THE ENGINEERING MAGAZINE

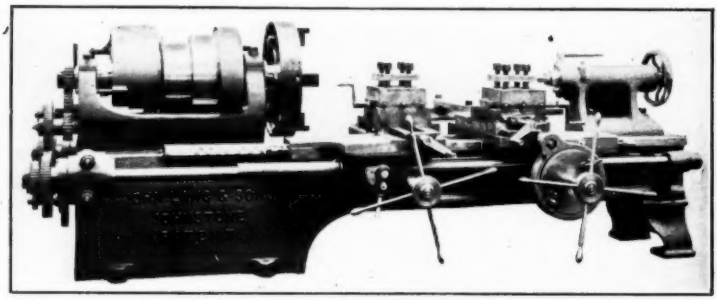
VOL. XXI. SEPTEMBER, 1901. NO 6.

ENGINEERING AT THE GLASGOW EXHIBITION.

By John G. Kerr, LL. D.

The exposition was doubtless first conceived as an effective instrumentality for influencing the buyer; it has taken on a new and almost a greater importance as an agency for broadening and bettering the practice of the manufacturer, by display of the best methods and products throughout all industry. This is even more apparent since the spread of internationalism in trade exchanges and trade competition. In this light, as concrete manifestations of the leading tendencies in applied engineering, we treat this month of the great expositions now open in the two great Anglo-Saxon industrial nations.—THE EDITORS.

GLASGOW, in virtue merely of its extensive and varied manufactures, its engineering shops and ship-building yards, may fairly be looked upon as one of the great centres of engineering enterprise in Britain. But we may go further and, with some show of reason, claim that the city of Black, Watt, Macquorn Rankine, and the Thomsons (Lord Kelvin and his distinguished brother) has in no casual way functioned as an active originating centre of engineering progress to the world at large. Not to the great researches and speculations associated with these names only does applied science confess her debt. No truly great man is without disciples, and from the lecture rooms and laboratories of the ancient University of Glasgow there have passed out into the work-a-day world many capable and enthusiastic students, who in process of time took rank as eminent physicists and engineers. It is fitting, therefore, that we should look for and find in the Exhibition opened in this city on May 2d, many and splendid

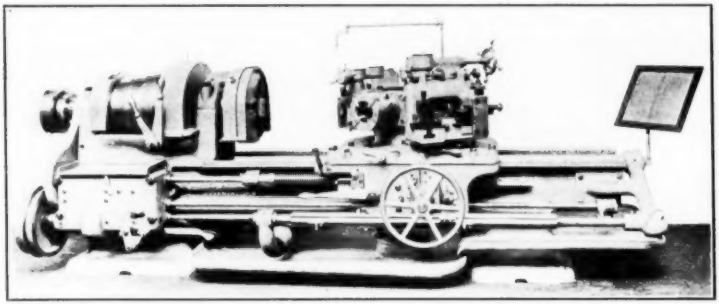


LATHE FOR TURNING SHELLS. JOHN LANG & SONS.

The saddle nearest the headstock forms the cylindrical part, while the other, with a radius-bar attachment, cuts the tapering nose.

evidences of the high degree of perfection which has been attained in all branches of mechanical science.

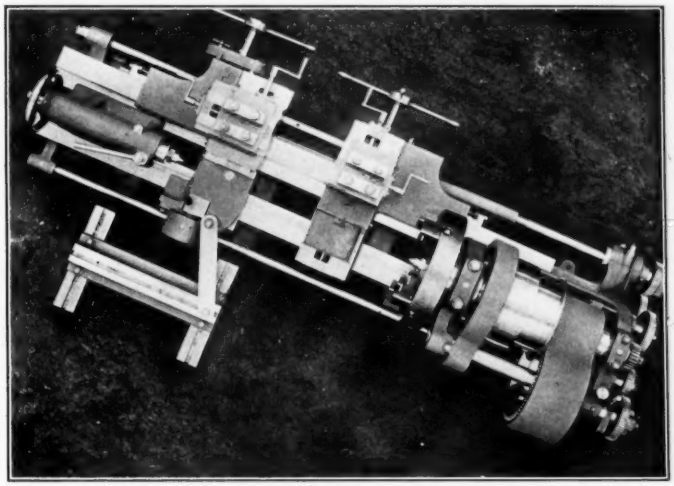
It is true, no doubt, that the extent of the Exhibition falls short of the marvellous display within the white palaces of the World's Fair at Chicago in 1893 and also that magnificent collection accommodated at Vincennes in the Paris Exhibition of last year. Yet what is lacking in amplitude is, I venture to say, compensated for by the representative character of the exhibits. From the international standpoint one could desire a more extensive representation. In explanation of shortcomings in this direction we may point to the fact that in all countries now demands are being made for rapid delivery of productions, and machinery cannot readily be dispensed with for the long period during which the Exhibition is opened. This is particularly true of the department which comprehensively is spoken of as Transport. Accordingly we find in such exhibits as railway locomotives a great falling off



NO. 4 PATENT HEXAGON TURRET LATHE, EXHIBITED BY ALFRED HERBERT, LTD., COVENTRY.

from that imposing array which formed outstanding sections at Chicago and at Paris. And we regret this the more as the subject of locomotive engineering and British practice occupies so much attention.

With machine tools, on the other hand, there is a very full demonstration, not only of American practice, which is finding such extensive support in Britain, but also of German tools; and at the same time it is made obvious by this exhibit that, however much British tool-makers may have lagged behind the Americans in appreciating the suitability and economy of automatic screw-cutting and capstan lathes, they are rapidly making up lee-way, and in some instances if not improving upon, they are at any rate seriously emulating their Trans-Atlantic instructors. Indeed, of some six hundred exhibitors who have stands



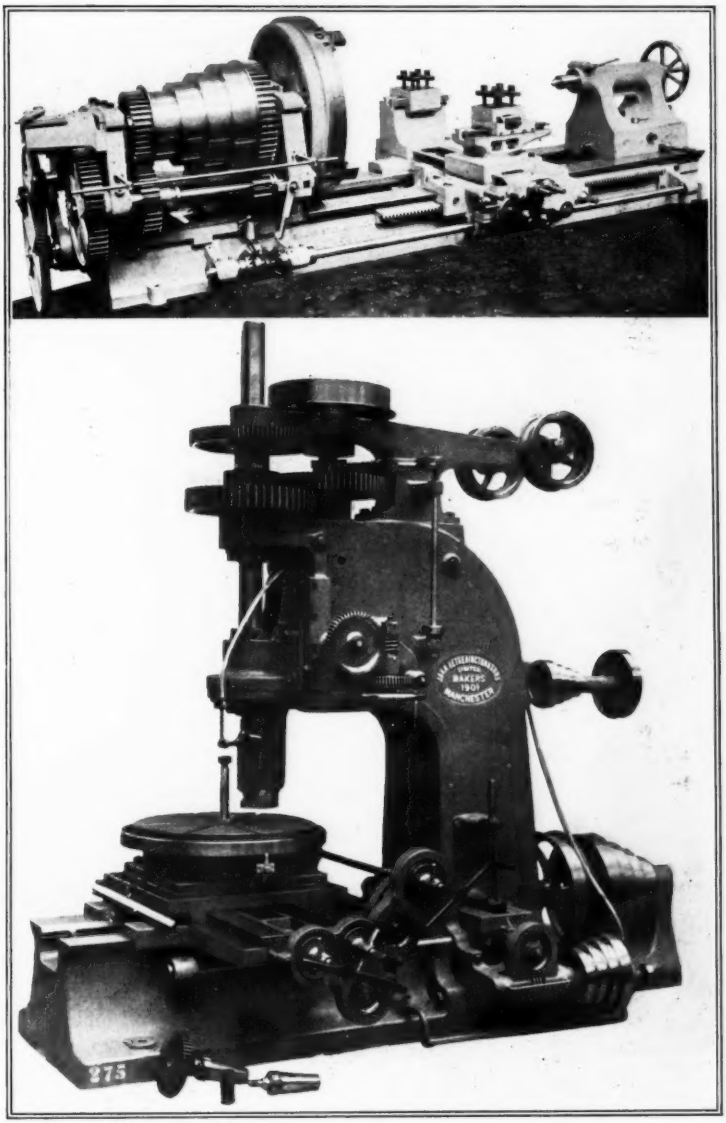
JOHN LANG & SONS' SHELL-TURNING LATHE. TOP VIEW.

in the large machinery hall, a very considerable proportion, say one-fifth, belong to this department, while in the series of pavilions lining the northwest upper avenue, familiarly spoken of as "Machinery Street," many additional machine-tool-making firms show their specialties. The largest capstan lathe in the Exhibition is by a British maker, Herbert of Coventry. It is of the hexagonal-turret type with special stop and feed motions and can deal with bars up to 3½-inches diameter. Messrs. Lang of Johnstone have several interesting novelties; among these a fine centering machine deserves attention. Their lathe for shells is well worth looking at. One saddle, that nearest the

headstock, forms the cylindrical portion of the projectile while the curved nose is formed by another with a radius bar attachment. Reference may also be made to a surfacing and boring tool with a 30-inch swing and so geared that by a simple motion of a handle the feed may range in six steps from 4 to 160 cuts per inch. Messrs. P. & W. Maclellan, of Glasgow, shew a lathe in which the headstock is given a swivelling motion to turn, without resetting, the concave end of a railway-wagon buffer. Messrs. Smith & Coventry have also a new turret lathe which combines the open-spindle bolt-machine system with the flat-turret arrangement. Messrs. Sharp, Stewart & Co. have an ingenious 10-inch capstan lathe, and the machine with its tools and tool-holders exhibited by the Jones and Lamson Machine Company repays inspection. It is hardly necessary here to deal with American tools, yet attention may be directed to a machine by the Bridgeport Automatic Machine Company for automatically cutting screw threads. The saddle travels to and fro along the lathe bed, the cutting tool being fed into its cut until the correct size has been reached. This tool is exhibited at the stand of Messrs. Selig Sonnenthal & Co., where also will be found a lathe with a special feed-change mechanism produced by the Hamilton Machine-Tool Co. of Ohio.

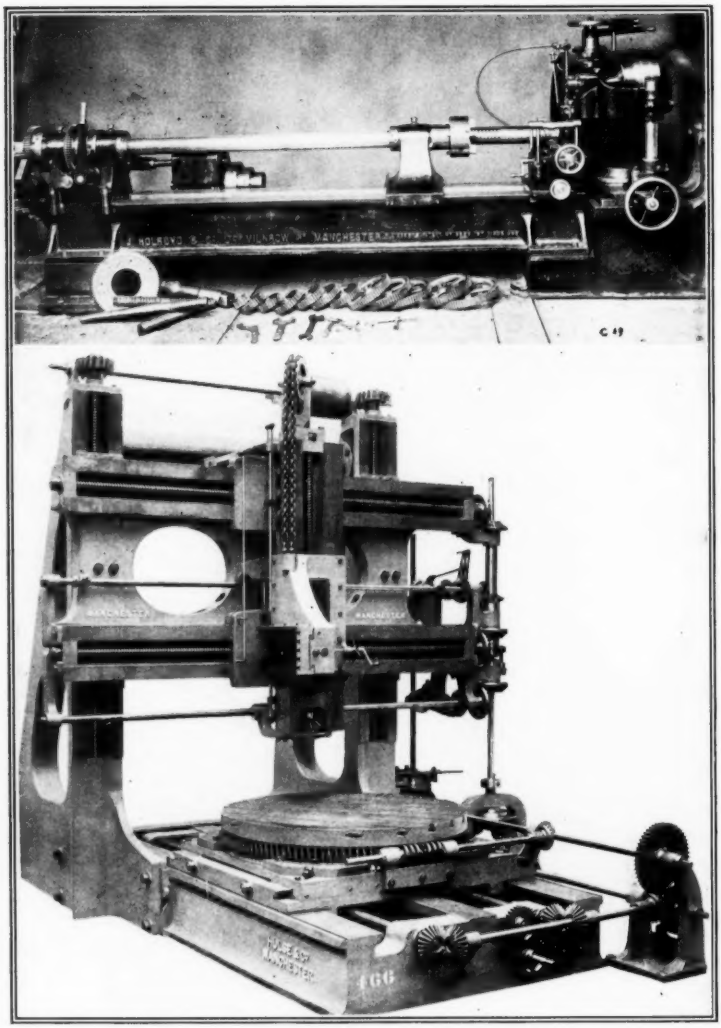
Most interest will no doubt be taken, particularly by foreign visitors, in the exhibit of large tools, for here at any rate Britain is not obviously behind her rivals, even although several large British engineering works possess American tools of this class. All the large makers are exhibiting. Messrs. Shanks, of Johnstone, have a particularly interesting stand shewing lathes, screwing, and turning machines, as well as the larger planing and slotting tools. Their 3-foot diameter grindstone is interesting on account of the protection afforded by the large, slightly concave, circular plates which are bolted on the square shaft carrying the stone, and which grip the latter on either side near its periphery. Of the many notable examples of large tools shewn by British makers we may direct attention to the exhibits of Messrs. Hetherington of Manchester, Sharp, Stewart & Co. of Glasgow, Hulse of Salford, and Holyroyd & Co., Manchester.

One feature of the Exhibition is the evidence it offers of the extent to which electricity is being applied in engineering, and it is obvious that with the rapid growth throughout Britain of large power stations further developments may be looked for. As instances of this application we have on the one hand small brass-finishers' tools driven with quarter-horse-power motors, and on the other large electrically driven pumps such as exhibited by Evans & Sons, Wolverhampton, or by the



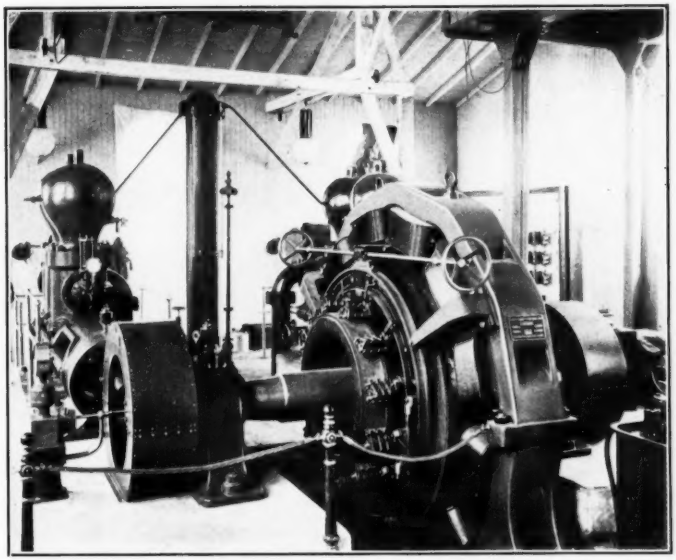
TYPICAL BRITISH HEAVY TOOLS IN THE GLASGOW EXHIBITION.

The upper machine is a 27-inch triple-geared surfacing and screw-cutting lathe with duplex rests, by Sharp, Stewart & Co., Ltd., Glasgow; for propeller shafts, gun tubes, or general work. The lower tool is a vertical milling and drilling machine by John Hetherington & Sons, Ltd., Manchester. It weighs about 15,700 lb., and the distance from spindle to upright is 2 ft. 3 in.

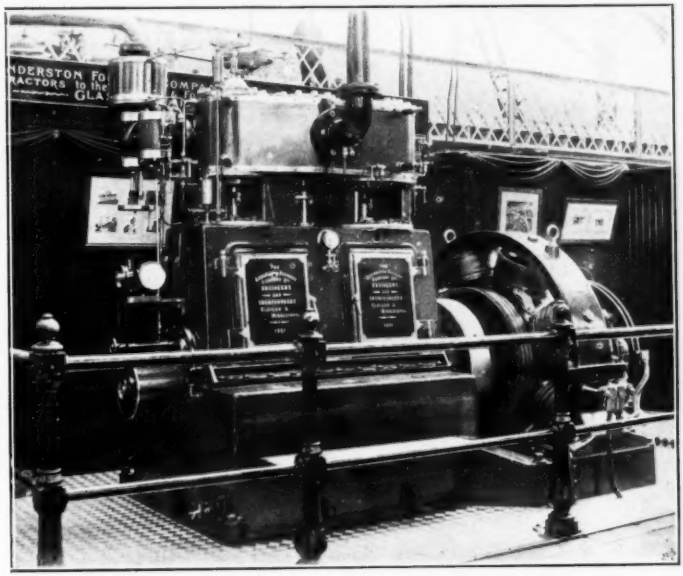


TYPICAL BRITISH HEAVY TOOLS IN THE GLASGOW EXHIBITION.

The upper cut is a screw milling machine, right or left-hand, by John Holroyd & Co., Manchester. Mills any length of screw-thread, square or other section, between the limits of 1 in. and 2¾ in. diameter, also threads of worms or screws not exceeding 5 in. diameter and 4 ft. length, whilst pitch may be varied from ⅛ in. to 2 in. Below is a special combined planing and slotting machine by Hulse & Co., Salford, Manchester, for planing cylinders, framing, etc., or slotting cranks of stationary or marine engines. Weighs 45 tons. Planes 9 ft. horizontally or 4 ft. vertically.

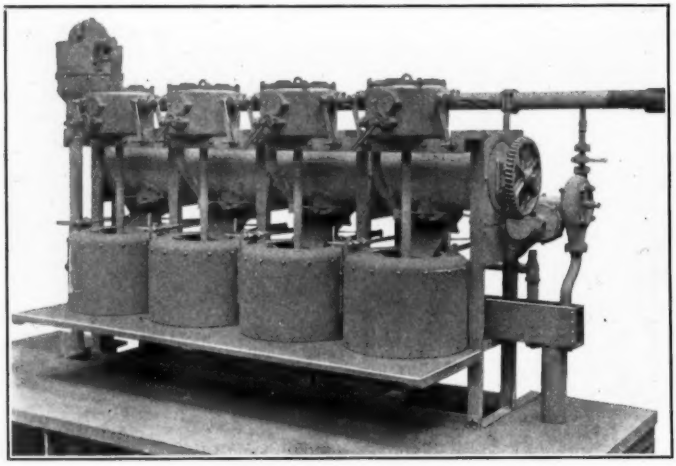


ELECTRICALLY DRIVEN PUMP SET. DRIVING END.
Exhibited by the British Shuckert Electric Co., Ltd., London.



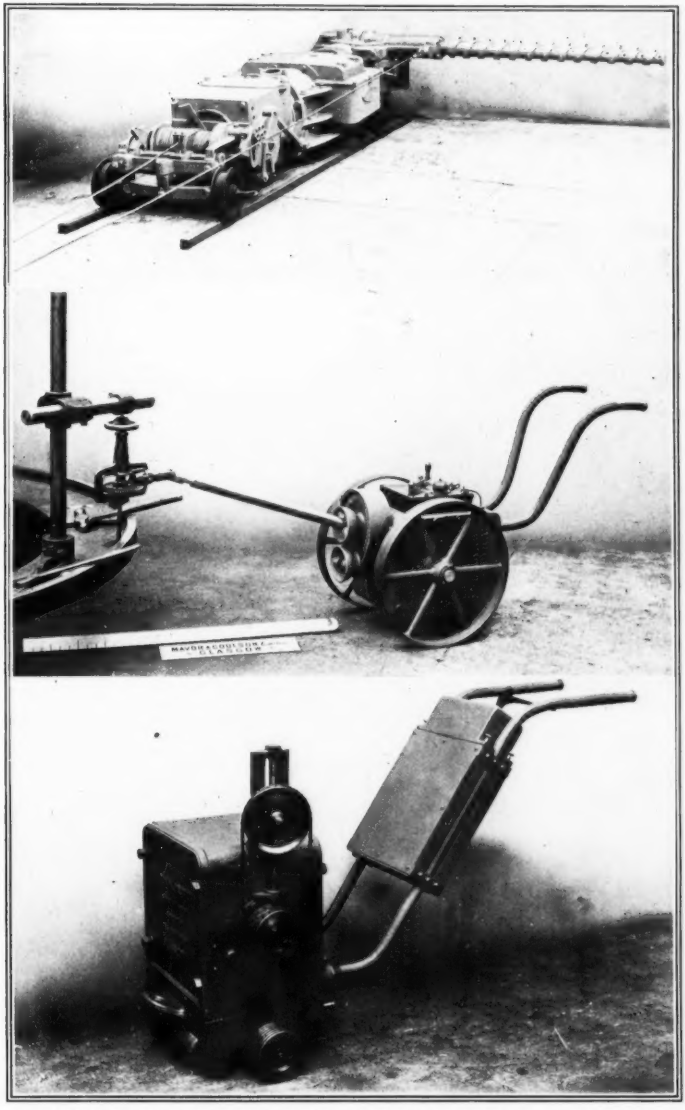
ENGINE AND DYNAMO SET, ANDERSTON FOUNDRY CO., GLASGOW.

Schukert Company. For centrifugals electricity seems specially available, the motor being applied either at the top of the spindle or under the pan. It should be remarked however that water power where it is available usually actuates centrifugals. Thus the Watson Laidlaw Company have adopted for this purpose the Pelton wheel, mounting it on the top of the spindle. Control of acceleration from the start right up to maximum speed is of consequence, on account of the differences in behaviour of various grades of sugar under the influence of the centrifugal, and this control is secured by means of a clever system of valves. We have with high-grade sugar a velocity of 850 revolutions attained in 45 seconds, whereas with fine-grained sugar it is desirable



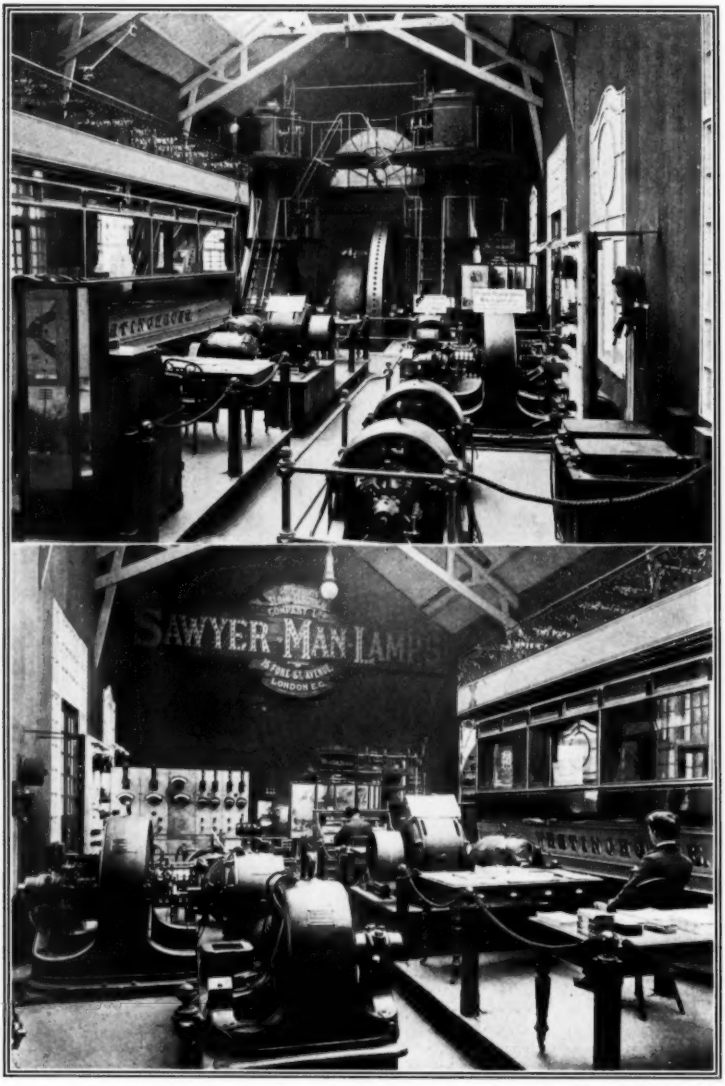
FOUR 30-INCH WATER-DRIVEN "WESTON" CENTRIFUGALS.
By Watson, Laidlaw & Co., Glasgow.

that this speed should not be attained until after, say, 3 minutes from the initial movement. The number of cases in which the motor may be spoken of as an integral part of the machine it drives is not very large. There are, however, several air compressors in which the motor is coupled direct to the shaft which actuates the compressor piston. Messrs. Mavor & Coulson of Glasgow shew several appliances, notably a deck-planing machine, a portable electric drill, and a coal-cutting machine in which the motor is really a part of the instrument. The motor of the deck-planing machine is 3-horse-power and makes some 3,000 revolutions per minute, the cutting knives attaining the same velocity. The expedition and economy with which this machine deals with ships' decks have secured its wide use in Germany and America



A GROUP OF ELECTRIC-DRIVEN TOOLS. MAVOR & COULSON, LTD., GLASGOW.

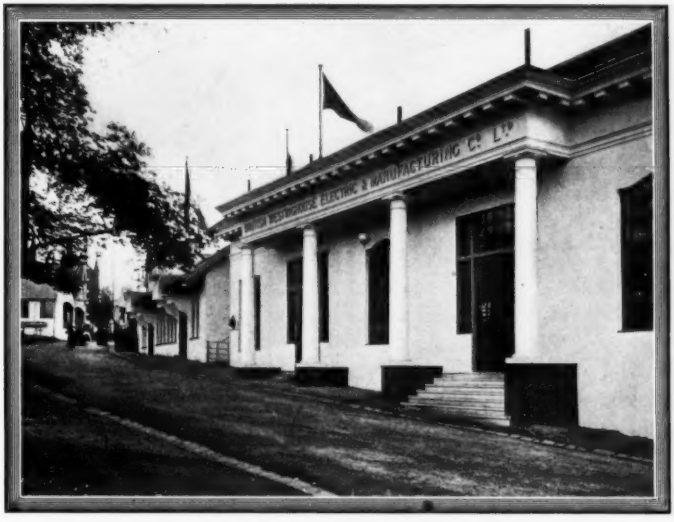
At the top is the coal-cutter, medium-size, for 4 ft. 6 in. undercut. Speed 400 r. p. m. Next is the portable drill, driving through telescopic or flexible shaft and adaptable (in three sizes) for drilling holes from ½ to 2 inches diameter, or for emery-wheel work. At the bottom is the deck planer, with 3 horse-power motor.



TWO VIEWS IN THE INTERIOR OF THE WESTINGHOUSE PAVILION AT THE GLASGOW EXPOSITION.

as well at home. The portable electric drill has a motor of the enclosed type with cast-steel shell, and is mounted on wheels. In the coal-cutting machine the motor is arranged in the centre of the instrument. The cutting bar, which revolves at 400 revolutions per minute, has a series of cutting picks. In addition to the forward movement given by the haulage gear a reciprocating movement is provided for see-sawing the bar out and in, in the holings.

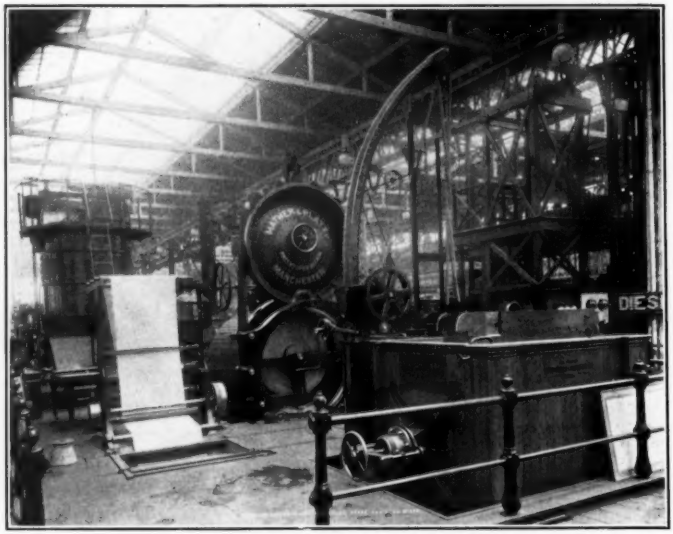
Another important electrically driven coal cutter is exhibited by Messrs. Clarke, Steavenson & Co. In this case the circular cutter works horizontally and the machine is so compact that the truck with its motor and gear may work its way through a face only 20 inches high and cut the seam level with the floor.



THE WESTINGHOUSE PAVILION AT GLASGOW.

It is not possible to overtake more than a few of the noteworthy applications of electricity to mechanism to be found in the Glasgow collection, and in referring to special cases I must not be considered as indifferent to such exhibits as those shewn by Messrs. Clarke Chapman & Co. of Gateshead-on-Tyne, the Sunderland Forge and Engineering Co., and other firms which have done distinguished service in this field.

There is a special educative advantage in the many-sided exhibit of mechanical devices for the textile, manufacturing, printing and other industries, for it will be borne in on young West of Scotland engineers



MACHINERY FOR OPEN-BLEACHING SYSTEM.
By Mather & Platt, Salford, Manchester. Shewing a new departure in principle. The bleaching liquors are made to pass through the cloth in bulk, instead of the cloth passing through the liquors.

that there is an unlimited scope for their ability and ingenuity, and that there are many branches of engineering which promise quite as liberal rewards for successful efforts as electric and marine work. The machinery is shewn at work, and in this respect indeed the Glasgow Exhibition is certainly ahead of many of its predecessors. Accordingly we find an extensive and at the same time a typical display of prime movers. Here also, however, the Exhibition is virtually British, and there are few opportunities of comparing what is done by Britons in this department with that which is met with in America, in Switzerland, and in Germany. Yet it may be affirmed that the engine-builders and the constructors of electricity generators are more than holding their own in efficiency and originality of design and make. I would note in passing the extensive show of high-speed engines for electric generation on board ship. It is not to be wondered at, considering the place which the Clyde occupies amongst the great ship-building ports of the world, that there should be here such a full demonstration of the best modern practice in this branch of engineering. The engines referred to vary from comparatively small units up to engines of 150 horse power with generators giving an output of 200 kilowatts. There

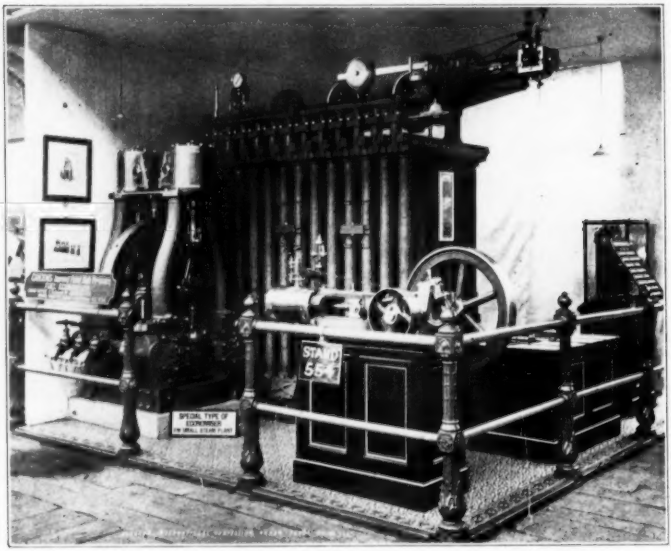
are two or three generators suitable for central stations for lighting and traction purposes, up to 1,200 kilowatts, driven by horizontal or by vertical engines, and also a machine of the marine type driving a large multipolar generator of 800 kilowatts. And so we have most systems illustrated. The voltage varies from 200 to 500. Several firms, however, and notably the British Shuckert, exhibit transformers dealing with currents of 10,000 volts, and in connection with these there are suitable switchboard mechanisms for such high potentials.

The steam-generating plant is accommodated in a special house adjoining the machinery hall. This plant includes not only the Lancashire boiler but also examples of tubular and of tubulous boilers. The four large boilers supplied by Messrs. Penman & Co. are 30 feet long and 8 feet in diameter and are worked at 100 pounds, each boiler being fitted with two deadweight safety-valves. The four are associated, one main steam pipe receiving steam from each of the boilers. The hot flue

OUTDOOR EXHIBIT OF THE DARLINGTON FORGE COMPANY. HEAVY FORGINGS FOR SHIP-BUILDING AND STRUCTURAL WORK.

gases before reaching the chimney are utilised in a Green's economiser which delivers the feed at a high temperature. The steam-generating plant of Messrs. Davey, Paxman & Co. includes a tubular boiler, a superheater, and an economiser. The steam generated from this set is used at a temperature of 650° F. in the company's large horizontal engine driving a 500-kilowatt generator to which reference will be made later. Messrs. Babcock & Wilcox supply three water-tube boilers, two land and one marine.

As to the Stirling boiler, two examples of which are in action in the boiler house, one with a Vickar's stoker, the other using producer gas, the principal change made since it was introduced into Great Britain is in the adoption of two water cylinders instead of one. The Stirling boiler delivers dry steam. The Davey-Paxman superheater

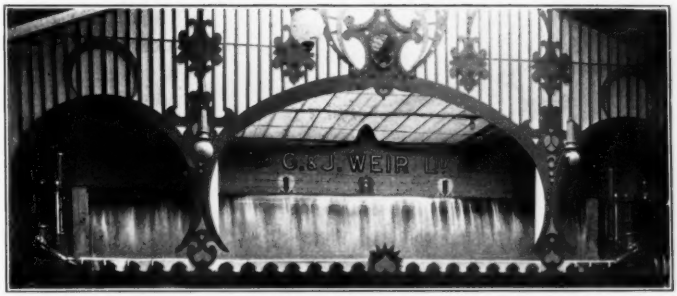


GLASGOW EXHIBIT OF GREEN'S FUEL ECONOMISER. SPECIAL TYPE FOR SMALL STEAM PLANT.

has been referred to; now to revert for a moment to the superheating arrangement which can be called into play in the Babcock & Wilcox boilers. Here U-shaped tubes, hanging below the drums in vertical planes with limbs horizontal, convey steam from the drums through the furnace gases and up to the steam-supply valve.

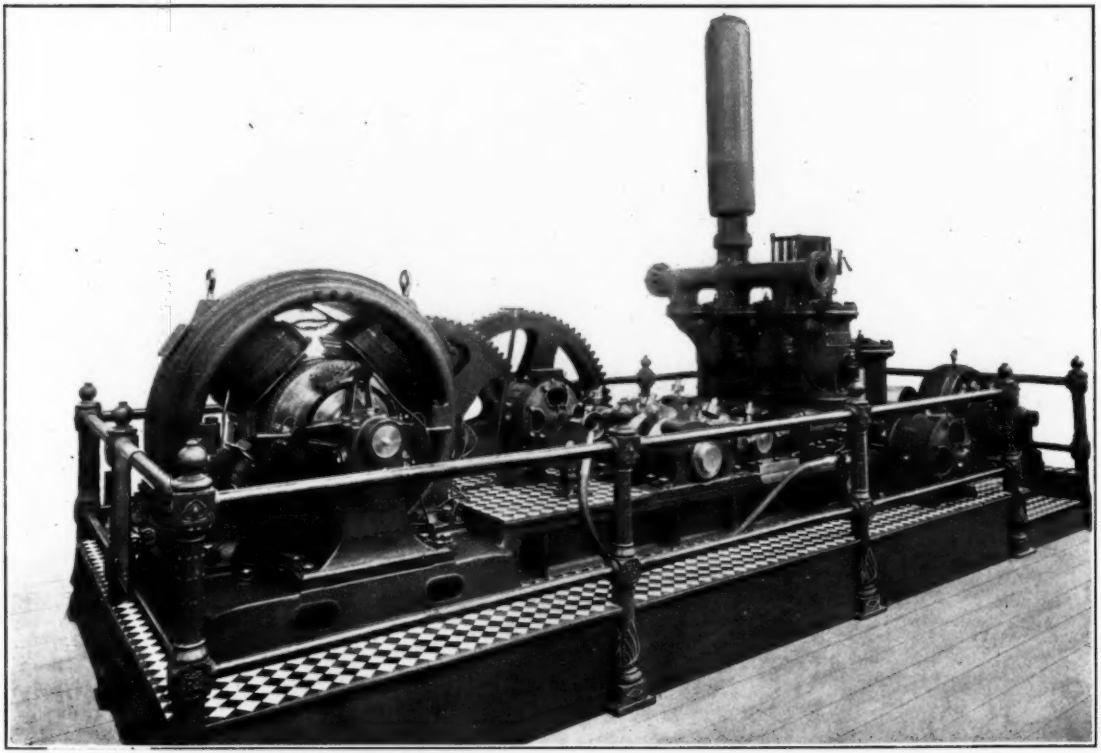
The question of superheating steam has from the first occupied the

attention of engineers. With the rapidly growing demand for power plant to be used in electric lighting and for traction, there is increased desire to effect economy in steam consumption. The results of experiments carried out on a large scale point to gain in this direction from superheating. Excellent results have also been got in using superheated steam on board ship. The Central Engineering Works, Hartlepool, have introduced this system into three steamers. The working pressure in the boilers, as appears in a report which announced a coal consumption of 97 pounds per hour per indicated horse power, was 267 pounds and the temperature on leaving the superheater about 480° F.

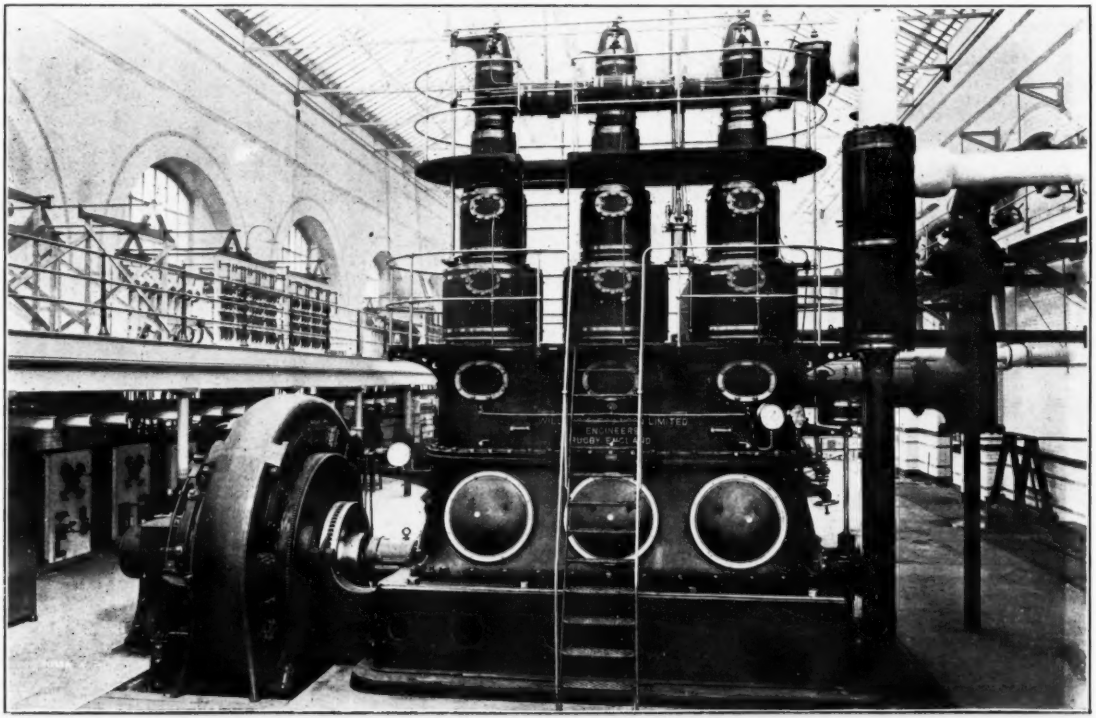


WATERFALL SUPPLIED BY A WEIR PUMP, PUMPING OVER THE SAME WATER CONTINUOUSLY.
G. & J. Weir, Limited, Cathcart, Glasgow.

In connection with the boiler installation various systems of pumps are at work. There are two vertical pumps on Weir's well-known system with a capacity of 3,600 gallons per hour, two corresponding pumps on the Worthington system, and also two by Carruthers, of Glasgow, for dealing with 6,000 gallons per hour; but these respective systems are so well-known that there could be no justification for entering here into details. It may however be remarked that Weir's pumps are almost universally adopted in the British navy and that they work satisfactorily against a pressure of 600 pounds to the square inch. The steam piping is designed on the ring system, the maximum internal diameter being 12 inches. Separators and steam traps are provided to deal with condensation within the pipes, and the expansion joints are fitted with brass glands. Feed-water heaters are in use. Those supplied by Royle of Manchester are constructed on Row's principle, in which an ingeniously contorted surface separates the feed from the steam which supplies heat. The feed-heating system introduced many years ago by Weir has a special interest for two very important reasons. First of all there is beyond all question an increase in



ELECTRIC-DRIVEN PUMPING SET, EXHIBITED BY THE ELECTRIC CONSTRUCTION COMPANY, WOLVERHAMPTON.



THE CENTRAL VALVE ENGINE OF WILLANS & ROBINSON, RUGBY, AS EXHIBITED AT GLASGOW.

They have on display two engines, each of normal 1200 h. p. with a maximum of 1500 h. p. The engines are triple-expansion three-crank, with cylinders 37.5, 23.6, and 15 in. diameter and 17 in. stroke; 230 r. p. m.; steam at 180 lb. The cranks run in an oil bath in the bed-plate. At present they exhaust to the air, but they are intended to run with condensation. One drives a Crompton dynamo of normal 790 kw. at 520 volts—the other a Shuckert dynamo of equal output. Floorspace 16 ft. by 8½ ft. Weight about 34 tons.

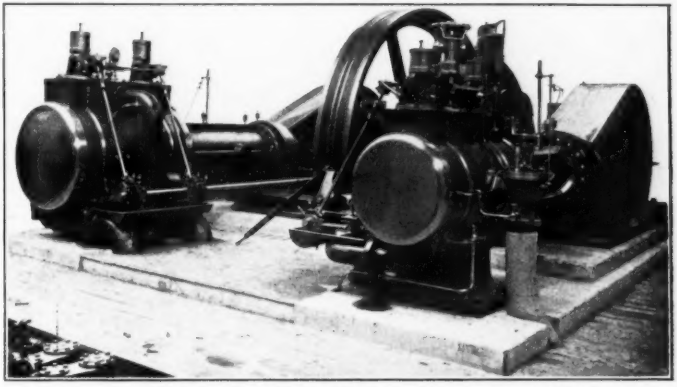
efficiency obtained by using in the feed-heater steam taken from the receiver of the low-pressure cylinder. This gain, which was outlined by the patentee in his original specification, has been got in practice and has also received an explanation at the hands of so eminent a physicist as Professor Cotterill. Secondly, there is a gain due to the influence which the method adopted for heating the feed-water has in eliminating corrosive gases.

Two noteworthy examples of engines are supplied by Messrs. Willans and Robinson, of Rugby. Their engines are 1,200 indicated horse power and of the central-valve type now largely adopted in central stations in Britain. Each engine has three cranks and each crank is worked with three cylinders on the superimposed system. The crank shaft is in one piece, with the eccentric forged solid on the crank pin. The uniform turning movement obtained by the multiple-cylinder system does away with the need for a large fly wheel and constancy of speed is further secured by the armature itself. To one of the engines a Crompton generator is coupled up, and to the other, one of the Schuckert multipolar generators shewn at Paris. Both these sets will have a permanent home in Glasgow, as they have been acquired for one of the electric-light stations of the Glasgow corporation.

Alongside of these splendid vertical engines is a horizontal engine by Messrs. Davey, Paxman & Co.—a very powerful machine with two cylinders. The main bearings are 8 feet 6 inches apart, and between these is mounted a traction generator of 300 kilowatts by the Electric Construction Co. of Wolverhampton. The valve-driving gears are placed in front of each main crank, instead of being keyed on the crank shaft on the inner side of the main bearing. The makers have kept in view the advantage of shortening the main shaft on which the heavy flywheel and the armature of the generator are mounted. In order that rapid changes of load may not seriously affect the speed of the engine, Paxman's automatic expansion gear, operating the piston valves which admit steam into cored recesses round the main piston valves, is applied to the high and the low-pressure cylinders. The engine uses superheated steam. Between the cylinders is an inter-heater fed with boiler steam superheated and so raising the temperature of the high-pressure exhaust considerably above saturation temperature. The low-pressure exhaust heats the feed water.

Messrs. Richardson Westgarth & Co., Hartlepool, exhibit a marine engine coupled to a generator of 300 kilowatts by Messrs. Brown Boveri & Co. The engine, which is designed to work with steam at 160-pounds pressure and develop 600 horse power, gives an example of

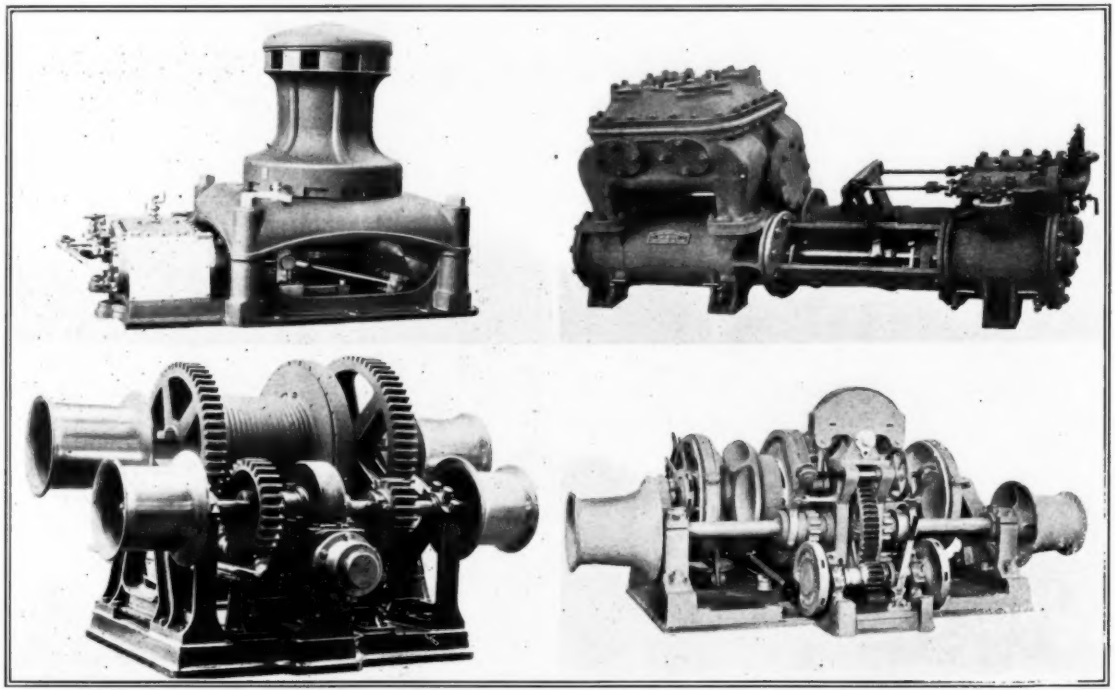
the firm's practice as regards marine work. The multipolar drum-wound generator gives a voltage of 230 when running 150 revolutions per minute. The 800-kilowatt generator, one of eight constructed for the Salford corporation tramways by Messrs. Mather & Platt of Manchester, is of the 10-pole compound-wound type. The armature is 8 feet 6 inches in diameter, while the commutator is about 7 feet and the shaft 15 inches. This large dynamo is driven by a Browett & Lindley 9-inch-stroke vertical engine at 100 revolutions per minute. Another engine worthy of note is that supplied by Robey & Co., Lincoln, and working one of Mavor & Coulson's 8-pole generators with an output of 350 kilowatts. This is the largest dynamo which has been constructed in Scotland. The engine driving it is of the cross-compound horizontal type with cylinders 20 inches and 35 inches diameter respectively and a



COUPLED COMPOUND ENGINE BY ROBEY & CO., LIM., LINCOLN.

stroke of 42 inches. At a standard speed of 90 revolutions per minute and a steam pressure of 150 pounds per square inch it gives an indicated horse power of 550. The frame is massive and the bearings large. Richardson's trip-gear admits steam in accordance with the load, and further control is secured by an electric regulator. Thus should it happen that short circuiting took place in the mains the engine would stop automatically.

The marine section of the exhibition is most comprehensive in its display. A magnificent collection of models, in themselves works of art, is arranged in the Grand Avenue and the Machinery Hall contains a very large and instructive representation of all kinds of marine engineering. It was not to be expected that many examples of main engines for screw propulsion would be on show. Nor was that needed,



A GROUP OF STEAM AND ELECTRIC-DRIVEN MARINE AUXILIARIES, BY CLARKE, CHAPMAN & CO., LTD., GATESHEAD-ON-TYNE.

The capstan is worked in double or single purchase by a horizontal engine 7¼ by 12 inches, or can be operated by hand. The cargo or ballast pump, horizontal duplex low-service type, has steam and water cylinders each 9 in. diameter and 10 in. stroke, gun-metal cylinders, plungers, valve seats, and glands. The electric winch is operated by a continuous-current motor and can lift 3 tons at rate of about 60 ft per minute on the barrel. The whipping drums, warp ends or barrel can be used together or separately. The windlass works by steam or by hand power and has direct drive between driving wheel and cable holder.

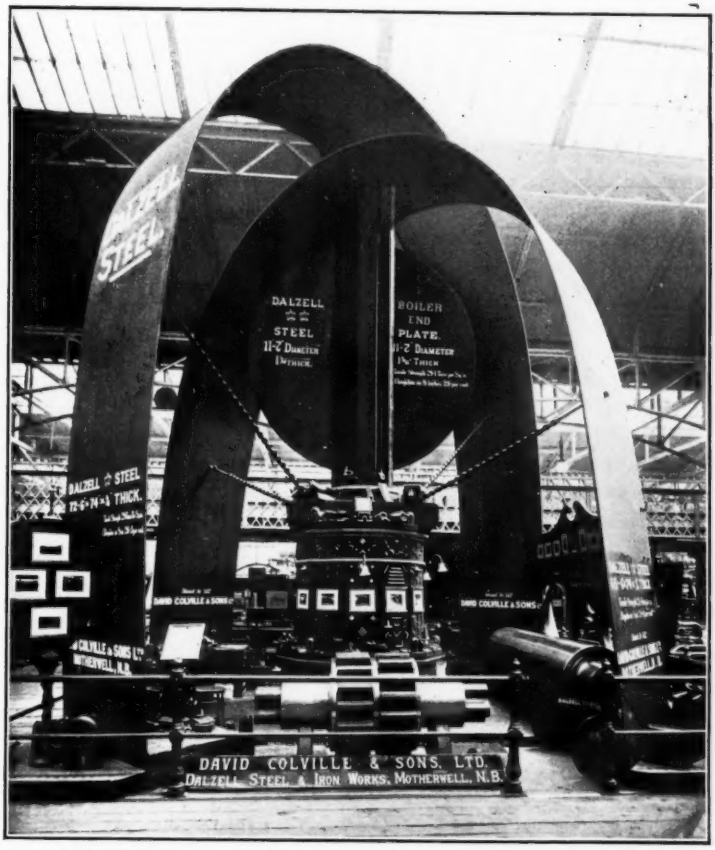
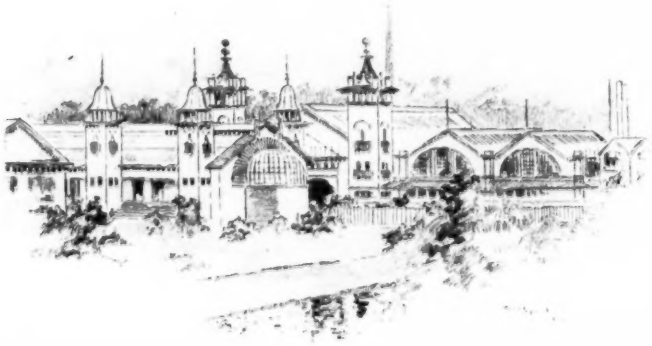


EXHIBIT OF IRON AND STEEL FORGINGS, CASTINGS, AND ROLLED SECTIONS.
David Colville & Sons, Ltd., Motherwell. The most striking exhibits are the steel plates, 72 ft. 6 in by 74 in. by 7/8 in., and 65 ft. by 74 in. by 15/16 in.

for the design of such engines necessarily moves along well-defined lines, unless, indeed, one is looking to such complete departure from previous forms as is illustrated in Parson's Turbinia and King Edward VII. Interest gathers specially round auxiliary machinery. In boiler-feed pumps some firms already referred to have built up a reputation for the perfection and reliability of their appliances. There are many examples of deck machinery driven by steam or by electricity. The marine engineer of today deals with large magnitudes and the problem of strength is always present. Consider, for example, the anchor

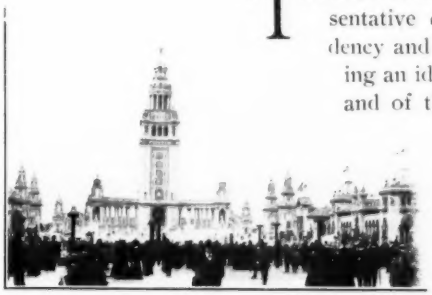
gear and brake arrangement needed to control the modern 20,000-ton ocean liner. Steel links of 3⅜ inches thickness now appear as the elements of great cables supplied to such vessels as the Oceanic and the Celtic. Within late years there has been a phenomenal development in size. But the other day the New York and Paris held a front place with a displacement of 10,000 tons. Now, at least fifty ships boast equal or greater tonnage. Twin-screw propulsion, as the models show, has become the rule and for the support of the propeller shafts the "spectacle" frame has been adopted. In addition to the increased facility with which the bearings can be examined, there is a further advantage from this arrangement, as tank experiments have indicated, in increased efficiency of the propeller. Brackets and other large forgings for Atlantic liners are exhibited by the Leeds Forge Co., Darlington Forge, Skoda, Beadmore, and others. The practice of scarfing the shell plating so as to reduce skin resistance has gradually extended and much larger plates are now being used than formerly. The Messrs. Colville of Motherwell shew a plate 72 feet long and 6 feet 1½ inch broad. One is tempted to enquire into the many changes which have been effected and to consider all the causes which have contributed to the reduction in coal consumption, for that of course is the vital question. Higher steam pressures, multiple expansion, higher piston speeds, heated draft, and superheating have all a share in the result, but perhaps instead of more pointed words it will be better merely to say that improvements in every direction have been and are being reached by naval architects and marine engineers and that this section, while possessed of great historical interest, must prove of special value on its purely scientific side.



MECHANICAL AND ELECTRICAL FEATURES OF THE PAN-AMERICAN EXPOSITION.

By Wm. S. Aldrich.

"To the great inventors and farseeing projectors, to the engineers, manufacturers, agriculturists, and merchants who have developed the resources of the New World, and multiplied the homes of Freemen."
Inscription, Panel I, Machinery and Transportation Building.



THE Pan-American Exposition is representative of the times—of the tendency and movement toward unfolding an ideal of international comity, and of the progress of civilization arising from the application of art and science to industry. It is a synonym for achievement. Passing through an age of discovery and a century of invention, the Western Continent is entering a period of development. The heritage of discovery left by Columbus was supplemented two hundred years later by Hennepin, the Humboldt of his day, accurately describing, illustrating, and naming Niagara. Scarce three-score and ten years have passed since Faraday discovered the principles of electro-magnetism that have made possible the utilization of this Niagara in an exposition which is the renaissance of the earliest Spanish influences to be seen in the art and architecture of the new world.

The grounds cover 350 acres, with 133 acres of improved park land. The court features cover 1,390,000 square feet, equal to the like areas of the Chicago and Paris Expositions combined. The architectural composition is true to new century ideals, the trend of the times in art and decoration, and the traditions and customs of the country. It is the product of American artists and architects, working out the problems of an exposition style with the old Spanish Mission as a starting point, into a complete and harmonious whole, unifying the composition in form, color, and sculptural decoration. By day it blends into

a color scheme universally recognized at once as most appropriate and effective. By night it affords an opportunity for electric illumination of surpassing beauty.

It was originally planned to have two great buildings, Machinery and Transportation, Manufactures and Liberal Arts, one on each side of the grand court; but there have been added the Agricultural and the Electricity buildings, similarly situated. Demands continued to be made for space, especially for the railway exhibits so typical of American engineering development. To accommodate these the Railway Exhibit building was added beyond the propylæa bounding the northern end of the court. The floor space for exhibits is equal to three-fourths that of the Chicago fair—too small in which to gather exhibits representing all types of American industries.

The electrical development of Niagara Falls and the utilization of 5,000 horse-power of its energy for the exterior illumination has made it possible to carry out a scheme of unprecedented boldness and beauty in the decorative lighting of the grounds, buildings, and electric tower. The power is generated at the central plant of the Niagara

THE ELECTRICITY BUILDING, BUFFALO PAN-AMERICAN EXPOSITION.

Copyright, 1901, by C. D. Arnold.

Drawn by F. Hopkinson Smith. Carrere & Hastings, N. Y., Architects.

THE TRIUMPHAL CAUSEWAY, PAN-AMERICAN EXPOSITION.

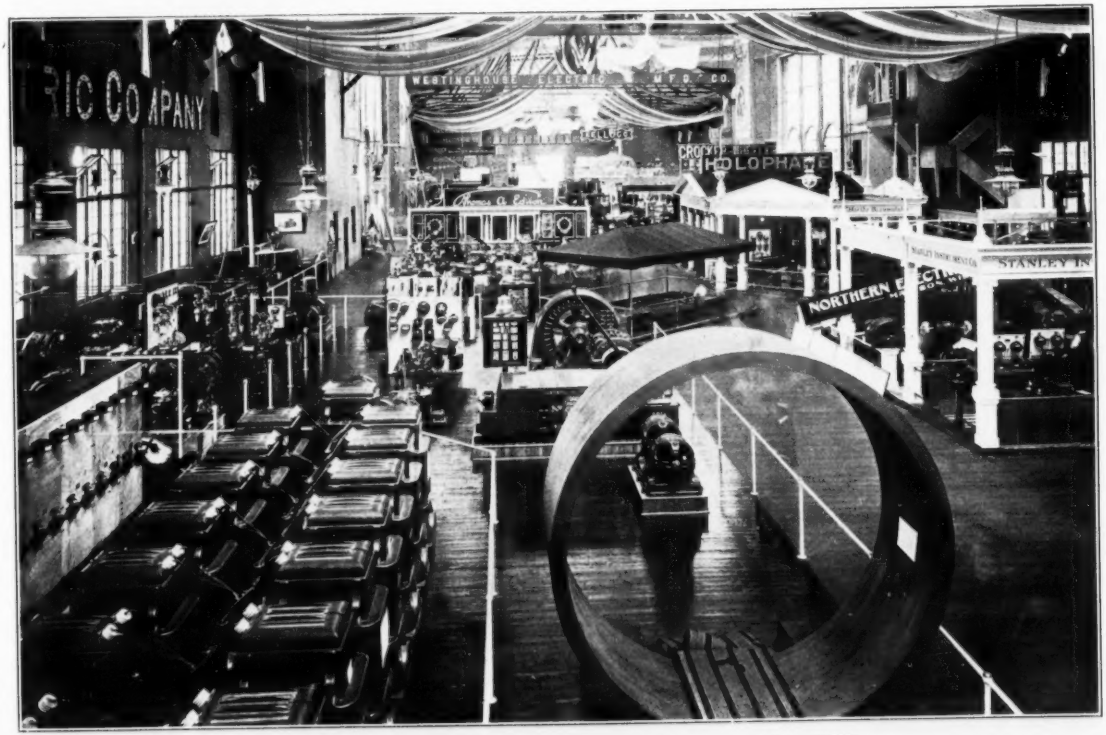
Falls Power Company, as two-phase alternating current of 25 cycles at 2,200 volts. It is at once transformed to 22,000 volts, three-phase, and transmitted 20 miles over the copper and aluminum lines to the terminal station on Ontario Street, Buffalo, where the voltage is reduced to 11,000. The current is thence transmitted 13,000 feet by a double three-phase line, of six bare copper wires of No. 00 (B & S

gauge) to the rheostat house, within the Exposition grounds, 650 feet north of the West Amherst Street gate.

The rheostat building is erected on posts, and houses the largest water rheostat ever built. It wholly controls the electrical supply for the exterior lighting. There are three water rheostats, one for each conductor of the polyphase current. Each rheostat consists of a tank, 3 feet wide, 3 feet deep, 7 feet long. Large blades, 6 feet long, are operated by a rope secured to a shaft driven through a worm gear by one-half horse-power direct-current electric motor. In this way all of the exterior incandescent lamps may be brought gradually up to full glow by lowering the blades into the water. The resistance diminishes till full metallic contact is made when the lamps are at full candle power. The water rheostat may be operated from the Electricity building and about 80 seconds usually elapse before the lamps are brought up to full incandescence.

From the rheostat house the Niagara power is transmitted through three lead-covered underground copper cables, of 300,000 circular mills each, laid in wood-box conduit, to the transforming sub-station in the northwest corner of the Electricity building. The lightning arresters, of the type made by the General Electric Company, are placed about ten feet from the underground cables. Entering the sub-station, the 11,000-volt current passes through an electrically-operated three-pole oil-break switch. This is of the type made by the General Electric Company, and adopted and first to be commercially used on a large scale in the power house and sub-stations of the Manhattan Elevated Railway, New York. It is operated by an electric motor, controlled either by hand from the main switchboard or by a magnetic overload circuit breaker, which closes the motor switch in case of a short circuit on the line.

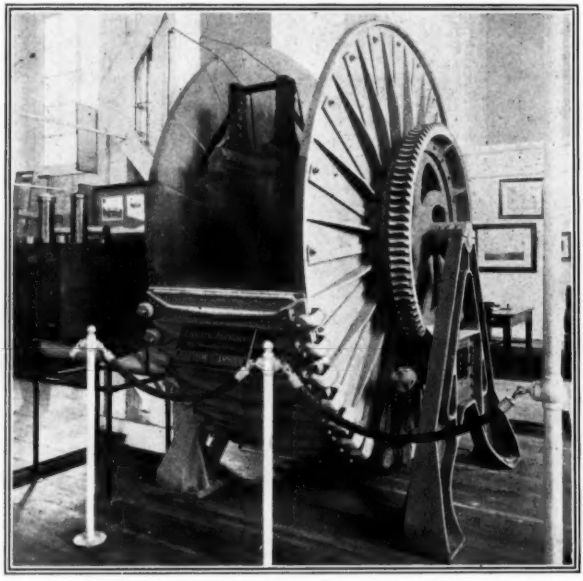
The transforming sub-station forms part of the exhibit of the General Electric Company, where eighteen 250-kilowatt air-blast transformers are installed, reducing the voltage of the Niagara current from 11,000 to 1,800. One extra transformer is held in reserve. This service is controlled through hand-operated oil-break switches and measured by an integrating wattmeter for each transformer. Adjacent to the transformers is the distributing switchboard, from which, through twelve three-phase feeder circuits, the current is supplied to the several transformer pits located throughout the grounds. There are about forty of these pits, containing various sizes of General Electric Co.'s oil-cooled transformers, reducing the voltage from 1,800 to 104, for the 8-candle-power incandescent lamps.



INTERIOR OF THE ELECTRICITY BUILDING, PAN-AMERICAN EXPOSITION.

In the left foreground is the transformer sub-station forming part of the General Electric Company's exhibit. The Westinghouse exhibit, shown on page 851, is at the extreme end of the hall.

Niagara power is not used throughout the Exposition elsewhere than for the exterior incandescent decorative lighting, and the alternating-current series arc lighting in the Electricity building. Its cost for this purpose is $30 per horse power, for the period of the Exposition, as measured at the Ontario Street terminal house.



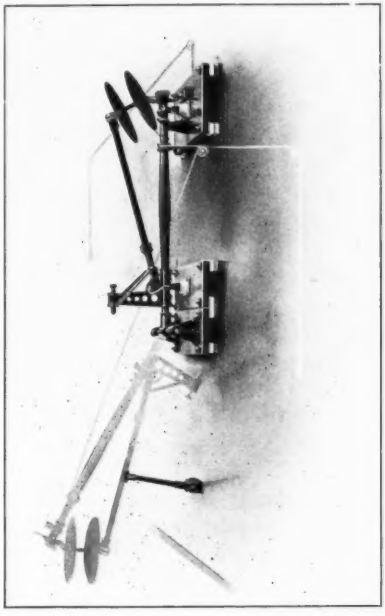
MODEL OF ELECTRIC FURNACE FOR MAKING CALCIUM CARBIDE, IN THE ACETYLENE BUILDING.

There is little to remind the visitor of the vast industries gathering about the Falls, except the model in the Acetylene building of the electric furnace for the manufacture of carbide of calcium. The Union Carbide Company, in its furnaces at the Falls, utilizes 20,000 horsepower of Niagara's electrical development, and the furnaces of other companies use 3,000 horse power for the manufacture of carborundum, 1,000 for graphite and 1,000 for emery products. The electro-chemical industries use 1,600 horse power for the manufacture of caustic soda and bleaching powder, 900 for sodium, 600 for phosphorus, and 500 for caustic potash and hydrochloric acid. The electro-metallurgical industries utilize 5,000 horse power for the reduction of aluminum, 600 for lead, and 100 for silver.

The use of models of great engineering developments for exhibition purposes is specially noted at the Pan-American. It becomes

more and more necessary in consideration of the nature and size of units of modern engineering projects, and in an exposition like this representing widely-separated districts and industries. For instance, the electrical development of water power is illustrated by a model of the Niagara Falls power plant, shown in plan and partially operative sectional elevation; an electrical manufacturing establishment by the model, as exhibited at Paris, of the works of the General Electric Co., Schenectady, N. Y., illuminated to produce day and night effects; naval and marine engineering by models of battle-ships and other naval vessels and mail steamers in the service of the Government; military engineering by models of ordnance, fortifications, and coast defenses; high-potential long-distance electric transmission by the model of the Standard Electric Company's installation, California.

The latest phase in the development of California water powers is exhibited by this last model. It shows the tributary watershed, the storage and distributing reservoirs, as well as the contour of the country traversed by the line, all in relief. The lines are of aluminum and aggregate 217 miles, the longest single stretch being 145 miles.



60,000-VOLT COMBINATION SWITCH AND FUSE
STANLEY ELECTRIC MANUFACTURING CO.
The third position is shown in skeleton.

The 60,000-volt combination switch and fuse for these most recent installations is exhibited by the Stanley Electric Manufacturing Co. Its operation depends upon drawing a metal fuse through a non-conducting powder enclosed in an insulated tube, the arc being ruptured as the fuse passes quickly through the powder. In its upright position the switch is closed. The fuse holder has large washers at each end and is held by the fuse which passes through it, between the vertical (main) arm and an auxiliary arm. The fuse carries the main circuit. An interlocking

device prevents the circuit being broken at the terminal jaws till the auxiliary arm has dropped into a horizontal position, assuring the circuit being open at the fuse. To open the switch by hand the upper end of the fuse is released by an unlatching arrangement provided for the purpose. The auxiliary arm is normally under the tension of a spring, assisting its pulling the fuse quickly through the powder. The automatic operation of the combination, from a short-circuit or other overload, is precisely similar, except that the fuse is fused and parted within the tube, instead of the upper end being released.

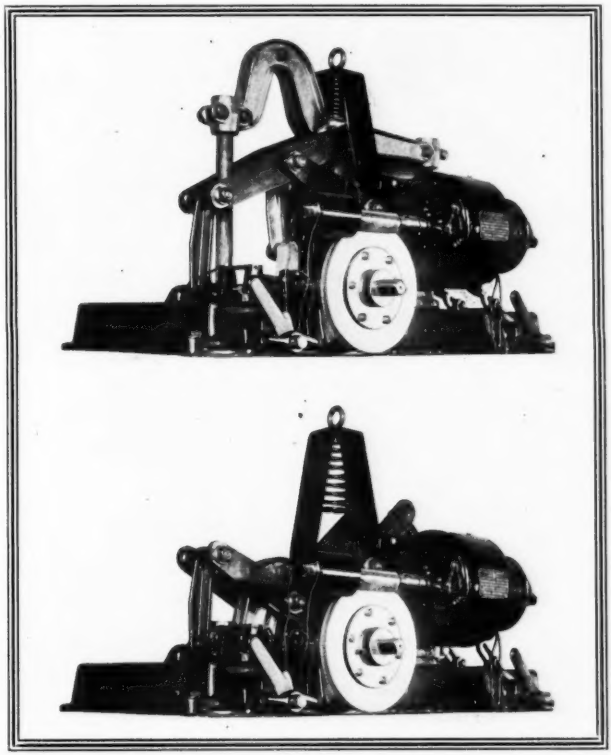
The question of fuse protection of high-potential circuits has also been satisfactorily solved by the same company, in their exhibit of 30,000-volt "ball" fuses. They are so constructed that when the fuse proper blows, carbon balls are driven into the air chambers arranged as receptacles and the arc is effectually ruptured.

In another new type of high-tension circuit breaker, exhibited by the General Electric Co., the break is made inside a long tube. The heated gases incident to the break throw out the piston which makes the contact, so breaking the arc, with a downward motion of the pistons, forming a double break on each phase.

The latest machine of the new type of compensated revolving-field alternator is exhibited by this company in a 200-kilowatt unit for direct connection to prime mover, to generate three-phase current at 2,300 volts, 60 cycles. It is specially designed to overcome the greatest difficulty in alternating-current supply, that of proper regulation of the voltage. The exciter is mounted on the machine and driven by enclosed gearing, to maintain it at a definite phase relation with the armature. Three collecting rings on the exciter armature are connected to the secondary of a transformer in series with the main circuit, increasing the voltage of the exciter with the load without any rectifying devices. This ensures better compensation for drop in voltage than is obtained by the usual earlier automatic methods, and maintains accurate voltage regulation under all varying external conditions of the load, for arc or incandescent-lighting or power service.

Alternating-current series enclosed-arc lighting, now coming into extensive use, is shown as a complete installation by the same company for lighting the interior of the Electricity building by this system. Niagara power is taken from the main transforming switchboard and reduced through three 50-kilowatt oil-cooled transformers, from 1,800 to 360 volts, for operating a 200-horse-power synchronous motor at 25 cycles. This machine is belted to a 100-kilowatt compensated revolving-field constant-potential alternator, generating

current at 2,300 volts and 60 cycles, as required by the arc-lighting service, supplied through the 75-light constant-current series transformer. This double transformation of electric energy, in voltage and frequency, by static transformers and motor-driven generators, as in the case of Niagara power above noted, is accomplished in one machine

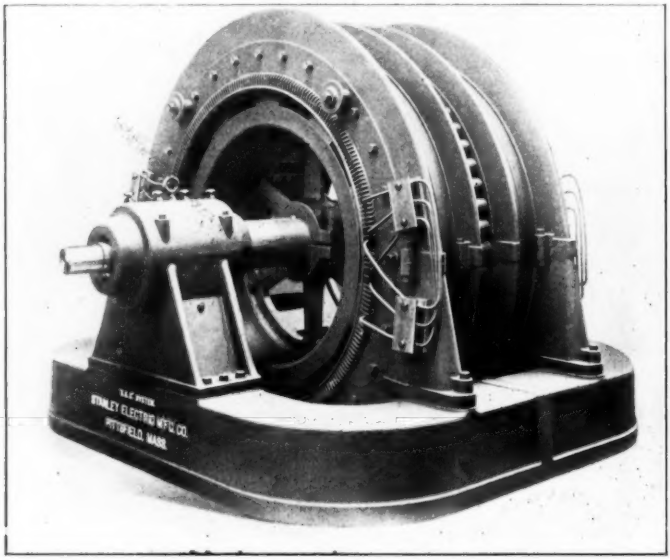


ELECTRICALLY OPERATED OIL SWITCH, 300 AMPERES, 10,000 VOLTS. SHOWING TWO POSITIONS.

General Electric Company's Exhibit.

by the "S. K. C. frequency changer" exhibited by the Stanley Manufacturing Co. It is of 80-kilowatt capacity, operating on three-phase current of 1,800 volts at 25 cycles, transforming it to two-phase, 2,250 volts, 60 cycles. An inductor alternator with a separate phase regulation by the same company, in the service power house of the Exposition, is of 300-kilowatt capacity, driven at 360 revolutions

per minute by belt from a Phoenix Iron Works engine, generating two-phase current at 60 cycles, of 2,400 (maximum) volts, operated at 2,200 volts, having a regulation of 20 per cent. The method of regulating the pressure in the individual phases is not shown in any other type of generator exhibited. It is accomplished by changing the effective turns on the armature by hand controller, cutting in or out the regulation coils and so raising or lowering the electromotive force of each phase independently.



THE STANLEY ELECTRIC MANUFACTURING COMPANY'S FREQUENCY CHANGER.
For changing current of low frequency to any required higher frequency and phase relation, especially in connection with lighting service.

The Nernst lamps in the grand dome of the Electricity building and below, around the Westinghouse exhibit, produce most beautiful lighting effects. This is specially noted in the early evening, upon comparing the illumination by arc and incandescent lamps with and without the Nernst lamps. When the current is turned on there is noticeable the characteristic way in which the Nernst lamps come to a full glow, with an agreeable acceleration of the glowing effect entirely lacking in the incandescent lamp. The 50-candle-power lamps reach full glow in from 15 to 20 seconds, the 175-candle-power in 25 to 30 seconds, the 400-candle-power in 30 to 45 seconds. They are

all operated on the alternating-current circuit of the Westinghouse exhibit, at 60 cycles and 220 volts.

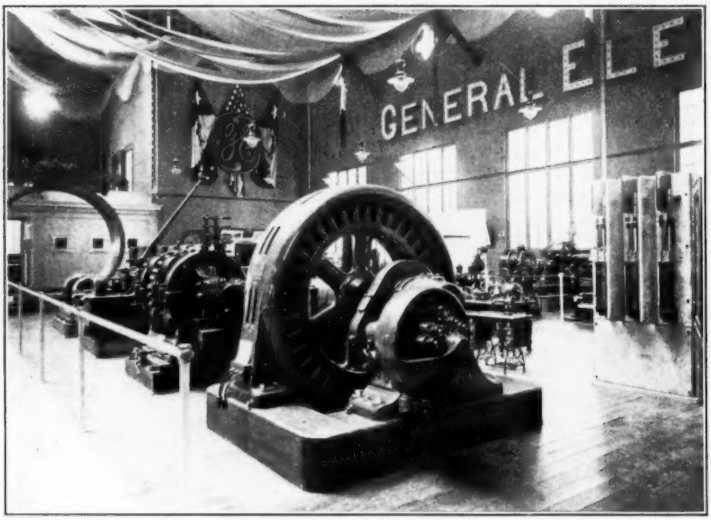
The color value of the Nernst lamp is unapproached by any other electric light. It is practically equal to sunlight in enabling one to match or detect delicate shades or tints in all classes of fabric or other material. Measurement of the comparative energy, in watts, required by a Nernst and an incandescent lamp of the same candle power constitutes another feature of this exhibit. The lamps and wattmeters are placed side by side. Numerous experiments have shown that the efficiency of the Nernst lamp is 1½ watts per mean spherical candle power against the usual 3½ watts for the same candle-power unit of the incandescent lamp.

The possible combinations of the Nernst unit adapt it for making lamps of various candle powers as required. The unit for all lamps is the 50-candle-power glower. For instance, three glowers are arranged, in multiple, to produce 175-candle-power Nernst lamp, six glowers for the 400-candle-power lamp, etc. It is therefore possible to supply an electric lamp of any candle power desired, between the ordinary 16-candle-power incandescent and the 450-candle-power arc lamp, as shown by the 175-candle-power Nernst lamp in use in the exhibit. The life of the Nernst lamp is double that of an incandescent lamp of the lowest watt consumption for the equivalent candle power. While the incandescent lamp rapidly falls off in candle power after the first few hundred hours of use, the Nernst lamp holds up to full candle power for practically its whole life. It only shows an appreciable falling off for the last 100 hours, and then the depreciation amounts to about 2 per cent. of its candle power.

Each glower in any of the combinations required for the various candle-power lamps is supplied with its own automatic heating and regulating device. The glower itself is composed of rare earths in the form of a rod of enamel joined at the ends to a platinum wire, making a rod about 1½ inches long and $^1/_{32}$ inch in diameter. Back of the glower is the heater, made of a platinum-wire-wound porcelain tube making a cylinder about ⅛ inch in diameter. Practically no current flows through the glower at first, owing to its being a non-conductor when cold. It is rapidly heated, however, by the rush of current through the heater coil, and reaching a high temperature becomes an excellent conductor. The glower receives its current through a small regulator made of iron wire enclosed in a glass tube. In series with the regulator and glower is the control magnet of the heater coil. When the current flows through the glower and regulator it passes next

through the control magnet, energizing it and cutting out the heater coil, of no further use when the lamp has been brought into service.

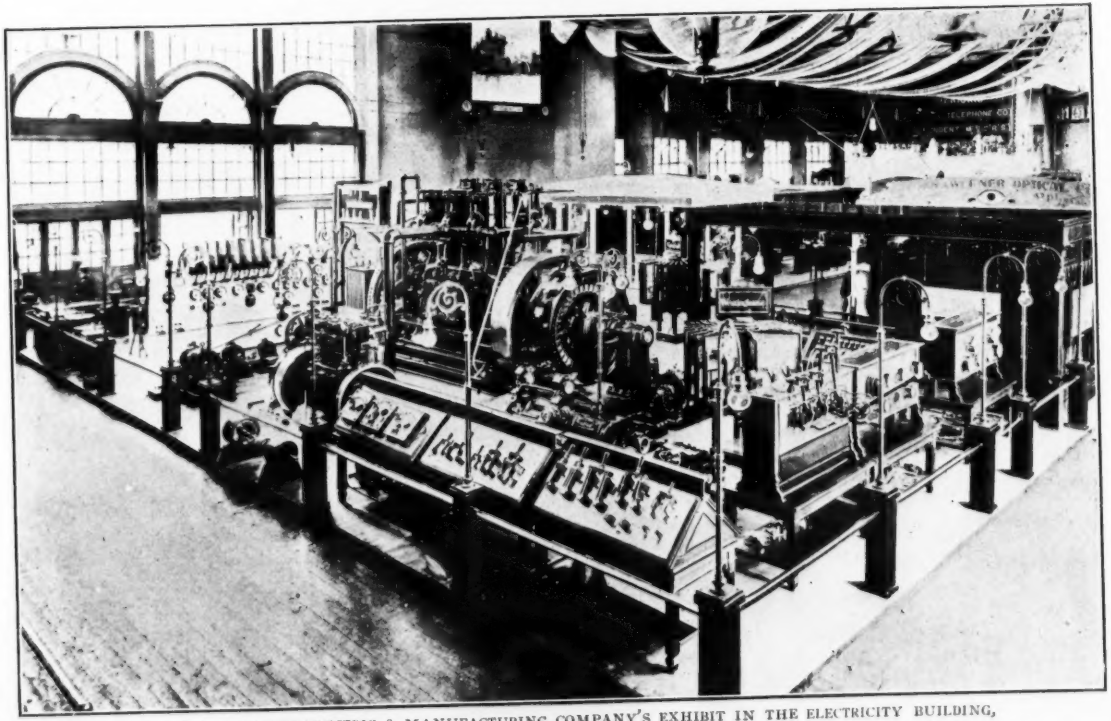
Exhibited at the Paris Exposition, in experimental form, the Nernst lamp has been so far perfected and developed by Mr. George Westinghouse, holding the rights for the United States, that the exhibit at the Pan-American may be considered epochal. This is the first public exhibition of Nernst lighting in America. Lamps are here shown in



PART OF THE GENERAL ELECTRIC COMPANY'S BUFFALO EXHIBIT.

daily use, varying in siezs from 50 to 2,000 candle power, the total exhibit being equal to 50,700 candle power.

The transmission of power by gas and its direct utilization in distant gas-engines for the generation of electricity, when and where required, is in marked contrast to the local electrical development of water powers and the transmission thence to the required spot. This Buffalo Exposition affords most interesting examples of each of these rival systems. Under the same roof of the Electricity building may be seen the models of the near-by electrical development of Niagara, with its 22,000-volt transmission; the distant development of California water powers with 60,000-volt transmission; and the local generation of electric power in the 300-horse-power direct-connected Westinghouse gas engine, supplied by natural gas from the Bradford fields, Kane county, Pennsylvania, 100 miles distant. The 2,200-volt

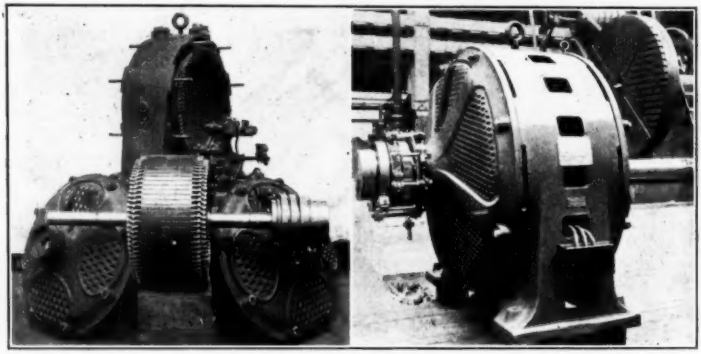


THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY'S EXHIBIT IN THE ELECTRICITY BUILDING, PAN-AMERICAN EXPOSITION.

60-cycle two-phase current here generated by a revolving-field alternator is used exclusively throughout the Westinghouse exhibit, principally supplying the Nernst lamps. A smaller 35-horse-power gas engine of the same type—that of the three-cylinder four-cycle—is direct-connected to the 25-kilowatt 125-volt direct-current generator, in the same exhibit.

Stationary gas-engines are exhibited of a dozen different forms, direct-connected or belted to dynamos, or belted to rotary pumps. Single-cylinder and two-cylinder (tandem) to three-cylinder vertical types are shown, the latter apparently having the preference.

The applications of electricity at the Exposition to power service are necessarily more varied than the lighting. They represent radical and successful departures, especially in the line of polyphase working, for which service induction motors are now made for both constant and variable speed. Two-phase variable-speed induction motors are exhibited by the Westinghouse Company. They have a regular armature winding for the rotor or secondary, connected up for three-phase star grouping, with terminals brought out to three collecting rings. Wires are run from these rings to a controller with non-in-

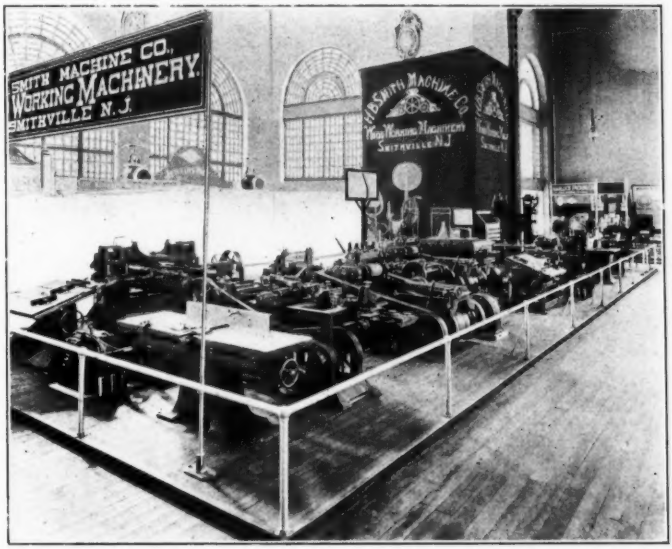


WESTINGHOUSE VARIABLE SPEED TWO-PHASE INDUCTION MOTOR, 200 HORSE POWER. On the left the parts are shown grouped; on the right is the completed motor.

ductive resistances, by varying the amount of which, in the secondary circuit, the speed may be varied at will. The speed is lowered below the normal by cutting in these resistances as part of the secondary circuit, which is thus always closed on itself through such variable external resistance.

Individual induction motors operate each machine of the complete wood-working establishment, exhibited by the Smith Machine

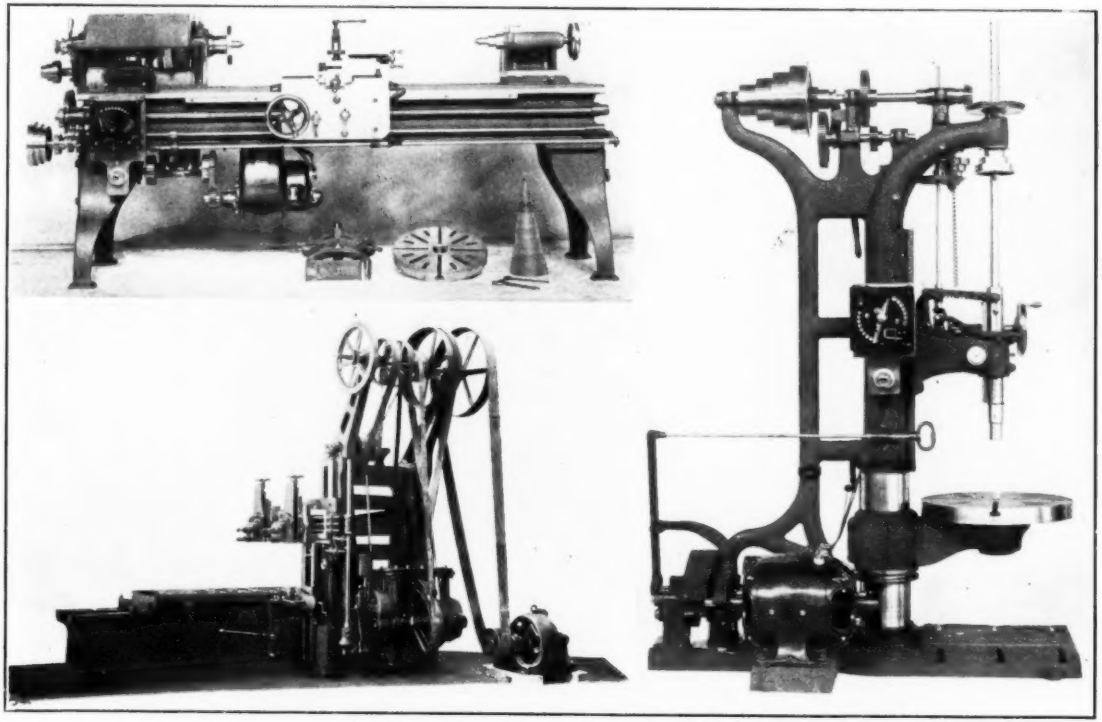
Co. in the Machinery building. These motors are of the Westinghouse two-phase constant-speed type, belted to the usual counter-shaft installed with each machine, and are made with the secondary or rotor of the ordinary short-circuited "squirrel-cage" construction. The only single-phase induction motors exhibited are those by the Wagner



WOOD-WORKING ESTABLISHMENT OPERATED ENTIRELY BY INDUCTION MOTORS.

Electric Manufacturing Co., in sizes from 2 to 30 horse power. This type of motor has but a single field winding, which through the connections provided in the simple self-starting arrangements makes it possible to start under full or over-load, as desired. A portion only of the armature is initially connected in series. A governor within the armature, on its attaining full speed, throws out this connection, and the armature is thence short-circuited on itself, the machine operating as a single-phase induction motor. A Wagner 5-horse-power 104-volt single-phase induction motor is direct-connected to a 25-volt direct-current generator for storage-battery charging in the Bell Telephone exhibit.

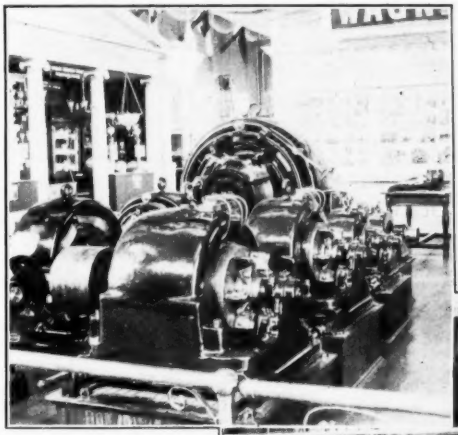
The Bullock system of power distribution, sometimes known as the "teaser" or multi-voltage system, for direct-current service is exhibited by the Bullock Electric Mfg. Co. The distribution is by multi-circuit wiring from the generator, supplying two or more



A GROUP OF ELECTRICALLY DRIVEN MACHINE TOOLS.

On the right is a 28-inch swing drilling machine operated by 2-horse-power electric motor; above on the left is a 16-inch swing engine lathe driven by 1-horse-power constant-speed motor. These are both exhibited by Prentice Bros. Co., of Worcester, Mass. Below on the left is a large tool driven by belted motor—a 42-inch open-side iron planer made and shown by the Detrick & Harvey Machine Co., of Baltimore. This machine is also built self-contained, with the motor carried on a bracket.

voltages as may be required to give the desired number of speed changes in the motors. These are therefore direct-connected or mounted on the machines to be driven and are operated through special controllers. Hence no wasteful resistances are employed as in the ordinary speed control of direct-current motors by variable rheostats or resistances. A Bullock motor of 6-horse-power, 220-volts, 350 revolutions per minute, drives a planer of the American Tool Works Co. in the Machinery building. Electric power distribution is seen in the driving of machines and tools. It has passed the experimental stage. In the Exposition are to be noted two modifications of the much-



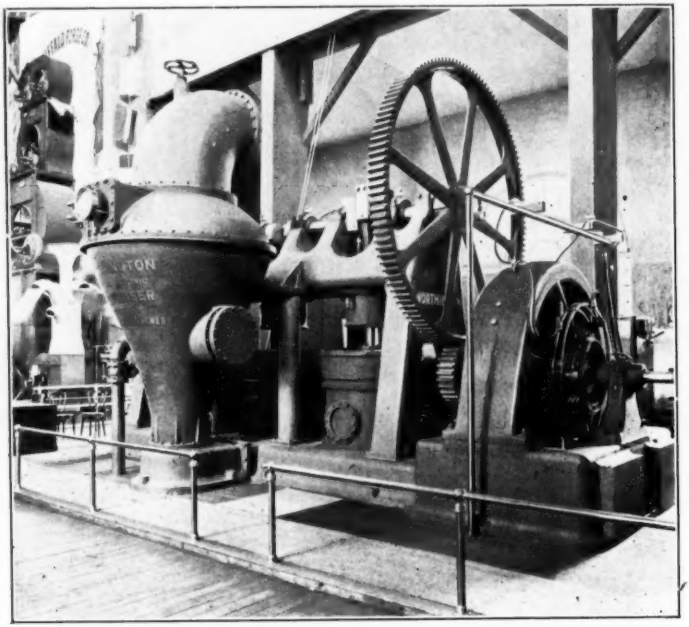
WAGNER SINGLE-PHASE INDUCTION MOTORS.

sought direct method of driving. First, the use of a constant-speed motor, with the usual mechanical arrangements of speed cones and change gears to obtain speed variations, making unnecessary any structural changes in the design of the machine. Second, the use of a variable-speed motor, with most direct connection possible to the spindle of the machine. There is a marked tendency to adopt the former method, not from any reluctance of manufacturers to change designs to adopt electric driving, but as the result of experience with variable-speed motor service. On a 16-inch lathe of one of the types exhibited

APPLICATION OF WAGNER INDUCTION MOTORS TO STORAGE-BATTERY CHARGING, BELL TELEPHONE EXHIBIT.

and driven by the former method, a ¾-horse-power 230-volt motor has been found more than ample, the lathe when so driven being capable of doing more work than by a belt drive, and all that the cutting tools will stand. Heavy torque crane motors and motors fitted with magnetic solenoidal brakes, not elsewhere shown, are exhibited by the Crocker-Wheeler Co., who show also a direct-current motor operating the hydraulic mechanism of a Gruson turret. The application of electric motors to heavy ordnance is shown also by the General Electric Co., for operating the disappearing carriage of a large coast-defense gun in the Government ordnance group.

Electric pumping is in evidence on every hand, both by alternating and by direct-current motors. Unprecedented application has been made in the exhibit of the Worthington 10,000-horse-power triplex electrically-operated air pump. It is driven by a single-reduction 150-horse-power 500-volt direct-current six-pole motor of the General Electric Co. Westinghouse direct-current 500-volt motors are in



ELECTRIC-DRIVEN AIR PUMP AND CONDENSER, 10,000 HORSE-POWER.

Exhibited by Henry R. Worthington. One of eight designed for the Manhattan Elevated Railway Power House, N. Y.

EXHIBIT OF ELECTRIC MINING LOCOMOTIVES—THE UPPER BALDWIN, THE LOWER GENERAL ELECTRIC.

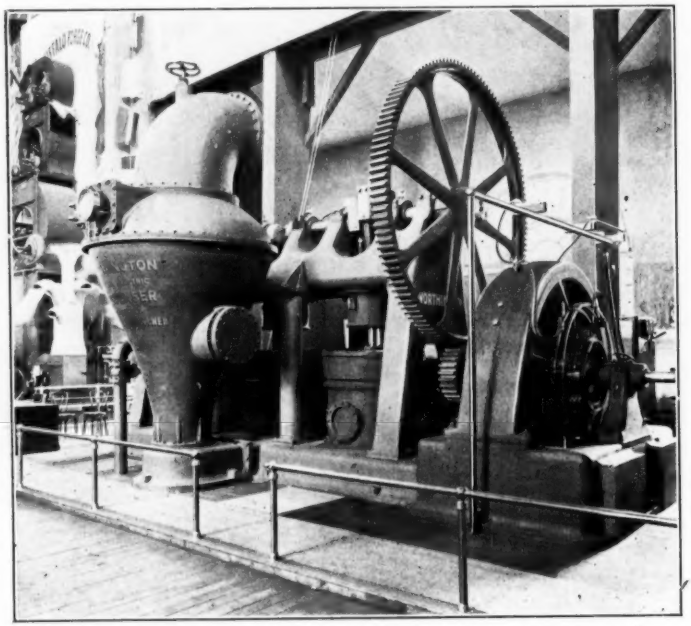
The General Electric locomotive weighs 10 tons, has two 40-horse-power motors for 500-volt line current, exerts a draw-bar pull of 3,500 lb. on level or of 5,000 lb. at starting, and attains a speed of 8 miles per hour with full load.

use for driving Roots' rotary pressure pumps; and in a mining exhibit a 50-horse-power General Electric three-phase induction motor is geared by single-reduction to a triplex or three-cylinder pump, running at 120 revolutions per minute.

Electric elevators and hoists are exhibited, from mine hoists operated by 500-volt direct-current geared motors, of the street-car type, to the superb exhibit of the Otis elevator in the Electric Tower. The automatic electromagnetic control for the Otis system constitutes an object lesson in itself, open for inspection on the ground floor of the

and driven by the former method, a ¾-horse-power 230-volt motor has been found more than ample, the lathe when so driven being capable of doing more work than by a belt drive, and all that the cutting tools will stand. Heavy torque crane motors and motors fitted with magnetic solenoidal brakes, not elsewhere shown, are exhibited by the Crocker-Wheeler Co., who show also a direct-current motor operating the hydraulic mechanism of a Gruson turret. The application of electric motors to heavy ordnance is shown also by the General Electric Co., for operating the disappearing carriage of a large coast-defense gun in the Government ordnance group.

Electric pumping is in evidence on every hand, both by alternating and by direct-current motors. Unprecedented application has been made in the exhibit of the Worthington 10,000-horse-power triplex electrically-operated air pump. It is driven by a single-reduction 150-horse-power 500-volt direct-current six-pole motor of the General Electric Co. Westinghouse direct-current 500-volt motors are in



ELECTRIC-DRIVEN AIR PUMP AND CONDENSER, 10,000 HORSE-POWER.

Exhibited by Henry R. Worthington. One of eight designed for the Manhattan Elevated Railway Power House, N. Y.

EXHIBIT OF ELECTRIC MINING LOCOMOTIVES—THE UPPER BALDWIN, THE LOWER GENERAL ELECTRIC.

The General Electric locomotive weighs 10 tons, has two 40-horse-power motors for 500-volt line current, exerts a draw-bar pull of 3,500 lb. on level or of 5,000 lb. at starting, and attains a speed of 8 miles per hour with full load.

use for driving Roots' rotary pressure pumps; and in a mining exhibit a 50-horse-power General Electric three-phase induction motor is geared by single-reduction to a triplex or three-cylinder pump, running at 120 revolutions per minute.

Electric elevators and hoists are exhibited, from mine hoists operated by 500-volt direct-current geared motors, of the street-car type, to the superb exhibit of the Otis elevator in the Electric Tower. The automatic electromagnetic control for the Otis system constitutes an object lesson in itself, open for inspection on the ground floor of the

tower. Electric traction, for flanged equipments, is represented by mining locomotives exhibited by the Baldwin-Westinghouse and the General Electric Companies. The ordinary requirements for such service are met by two 500-volt single-reduction motors, to develop 50 horse power on normal railway rating, at speed of six miles per hour, and with a capacity of 100 horse power at speed of eight miles per hour, on level. The full-load draw-bar pull, on level, is about 4,300 pounds; the starting draw-bar pull, on level, 6,000 pounds. Rheostatic control is chiefly used, and the total weight of locomotive is about 26,000 pounds. The new multiple-unit system as it is to be applied on the Manhattan Elevated Railway is publicly exhibited for the first time by the General Electric Co.; 125-horse-power motors are shown with the auxiliary parts of the equipment for one car.

A new electromagnetic brake and car-heating apparatus is shown by the Westinghouse Co. in two exhibits: first, a maximum traction double-truck equipment, with two 40-horse-power motors and brake, operated on a short section of track, from stationary controller, to show the great braking power of the system and the freedom of the wheels from skidding; second, a standard single-truck electric car similarly equipped and in operation. A simple additional mechanism to an ordinary street-car controller makes it possible to operate the motors as generators, when the car is in motion and disconnected from the line supply. Current is now supplied by the motors as generators, for exciting the brake magnets, through the friction shoes of which a strong magnetic attraction is set up with the rails, the drag of which operating through suitable levers applies the regular brake shoes to the wheels.

The self-propelled vehicles and launches constitute an exhibit of never-ending interest, from the many attempts to solve the problem by electricity, by steam, and by internal-combustion engines. About one-half of the automobile exhibit shows steam-driven vehicles, the other half dividing the honors equally between electric motors, operated by storage batteries, and some form of gasoline motor. One is specially impressed by the refinement in design and workshop production, evident in these attempts to obtain necessary power at high and variable speeds with minimum weight and size of equipment.

An application of electrically-operated control for steam-engines is shown in the Monarch engine-stop system, applied to the Fitchburg engine in the pumping plant. This engine is 18 by 42 inches, developing 250 horse power at 86 revolutions per minute, and operates one of the Roots' rotary pumps. The Monarch safety system is oper-

ated by electricity and gravity combined. The electric parts of the device serve to connect different parts of the plant, as may be desired, near or remote, with the throttle-valve, by means of push buttons, and also directly with the shaft to stop the engine in case of racing or over-speed. Pressing the button at any point, in case of accident, will unlock the system, closing the throttle-valve by gravity.

Telegraphy and telephony are well represented by some of the latest types of conventional equipment showing a high state of the art. The telautograph and electrograph are also exhibited, the former for reproducing handwriting and the latter for reproducing pic-

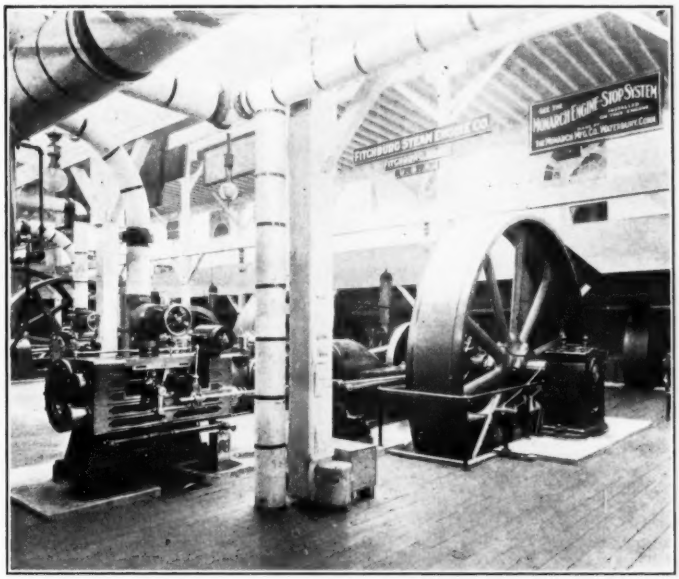
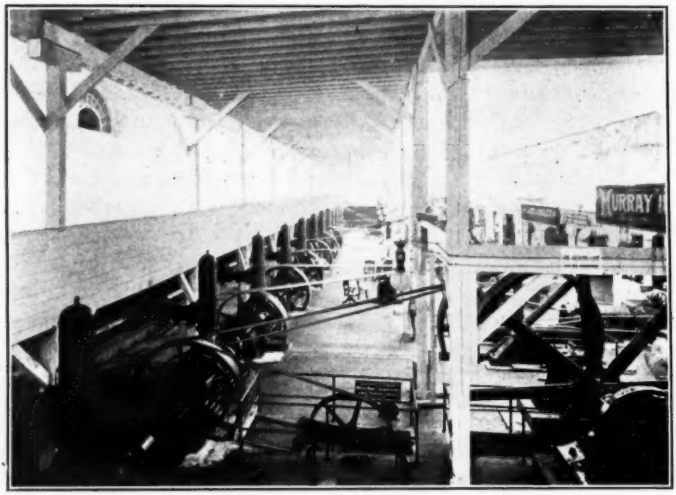


EXHIBIT OF THE MONARCH ENGINE-STOP SYSTEM.

tures at a distance. Interest in wireless telegraphy for the time overshadows that earlier shown in X-ray developments. The former is illustrated by an exhibit in the Government building, the latter by apparatus in the Electricity building, by means of which most remarkable and exact determinations are shown to have been made of the location of metallic bodies in the human system.

The pumping plant in the court of the Machinery building contains a most interesting collection of steam and gas engines, of various makes, belted respectively to twelve Roots' rotary pumps.



STEAM PUMPING PLANT, COURT OF MACHINERY BUILDING.
Showing exhibit of fountain pumps, P. H. & F. M. Roots Co., Connersville, Ind.

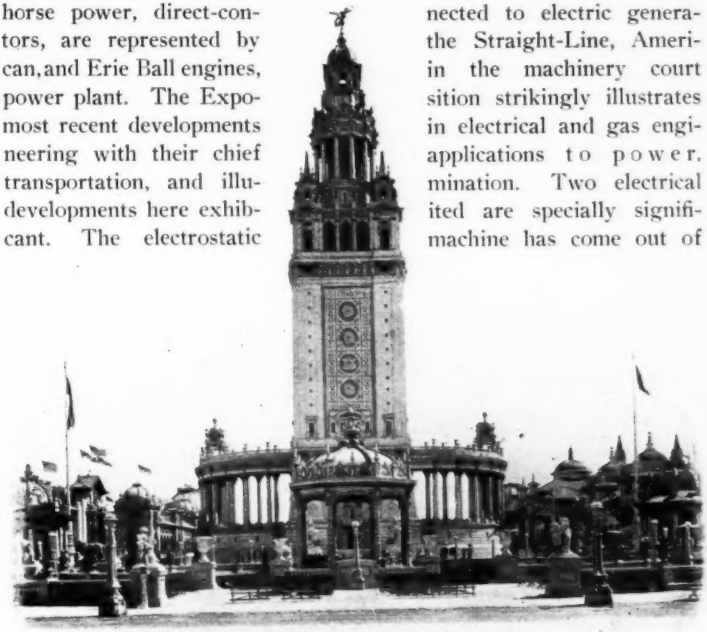
There are five other pumps of this type on the grounds, handling the water in connection with the fountains, cascades, etc., of a combined capacity of 35,000 gallons per minute and absorbing about 2,500 horse-power. Water is supplied through a 48-inch suction pipe intake and delivered through 16-inch and 20-inch pipes, at 110-pounds pressure, to the fountain orifices.

The American Ball compound engine in this power plant represents a radical departure in high-speed-engine design. The two cylinders are placed side-by-side, operated by a single valve, with their piston rods connected to the same cross-head. The principle employed is similar to that shown in the Vauclain type of compound locomotive for the Lehigh Valley R. R., No. 1211, exhibited by the Baldwin Locomotive Works, in the Railway Exhibit building. A saving of 25 per cent. in fuel over the simple engine is claimed for this system of high-pressure compounding.

The railway exhibits, in the small building set apart for them, are as thoroughly representative as possible of the peculiarly American transportation systems and safety appliances. Even to the layman it will be evident that every precaution is taken for his safety in travel, from the exhibits and operating models of installations of the Westinghouse and New York Air Brake systems, the Union Switch & Signal Company, the Gould electric train lighting, and the Pyle electric

head-light for locomotives. The magnificent engines of most recent types of construction include the Baldwin compound (Vauclain system), the Schenectady and Richmond compounds (two-cylinder systems), and the Brooks' high-speed engines (single-cylinder type).

There are two boiler installations, of a total of 4,000 horse power, for supplying steam for the two power plants, at from 110 to 125-pounds pressure. The boilers are all of the vertical type, fired by the natural gas piped to the Exposition, and using the Kirkwood burners. The gas consumption is about 30 cubic feet per boiler-horse-power hour. The service steam-power plant of the Exposition, as its name implies, is therefore an emergency plant. Its use of new and second-hand engines, without exception belted to new and second-hand dynamos, is not expected to represent latest and best practice. High-speed automatic steam engines, simple or compound, from 100 to 200 horse power, direct-connected to electric generators, are represented by the Straight-Line, American, and Erie Ball engines, in the machinery court power plant. The Exposition strikingly illustrates most recent developments in electrical and gas engineering with their chief applications to power transportation, and illumination. Two electrical developments here exhibited are specially significant. The electrostatic machine has come out of



THE ELECTRIC TOWER AT BUFFALO, SEEN FROM THE NORTH.
Copyright, 1901, by C. D. Arnold.

TRANSPORTATION EXHIBIT AT THE PAN-AMERICAN.

the laboratory and the museum to do its share of service. The storage battery has reached into the fields of lighting, transportation, telegraphy, and telephony. The largest single cell in the world is exhibited, of the Gould type, with plates 15½ inches by 31 inches, of total weight of 8,750 pounds, and a capacity of 2,000 amperes for eight hours; while the new Edison cell is placed on exhibition, of 100 watt-hours capacity, weighing 5¾ pounds, with iron and nickel elements in an alkaline solution.

Electrical transmission for exposition power is a marked success. We shall not see again, for this purpose, great central engines with long lines of steam piping and shafting. By electric driving a certain fitness has been readily secured in the location of exhibits as related to their architectural environment. It lends itself admirably to desired interior arrangements and decorative details. Examples are to be seen within this Exposition of the development, transmission, and utilization of power by water, gas, steam, compressed air, and electricity. It is clear that an effort has been made to do the other motive powers justice. But it was practically impossible in such an exposition, where the battle of the motive powers is so unevenly waged beneath the shadow of the Spirit of Niagara.

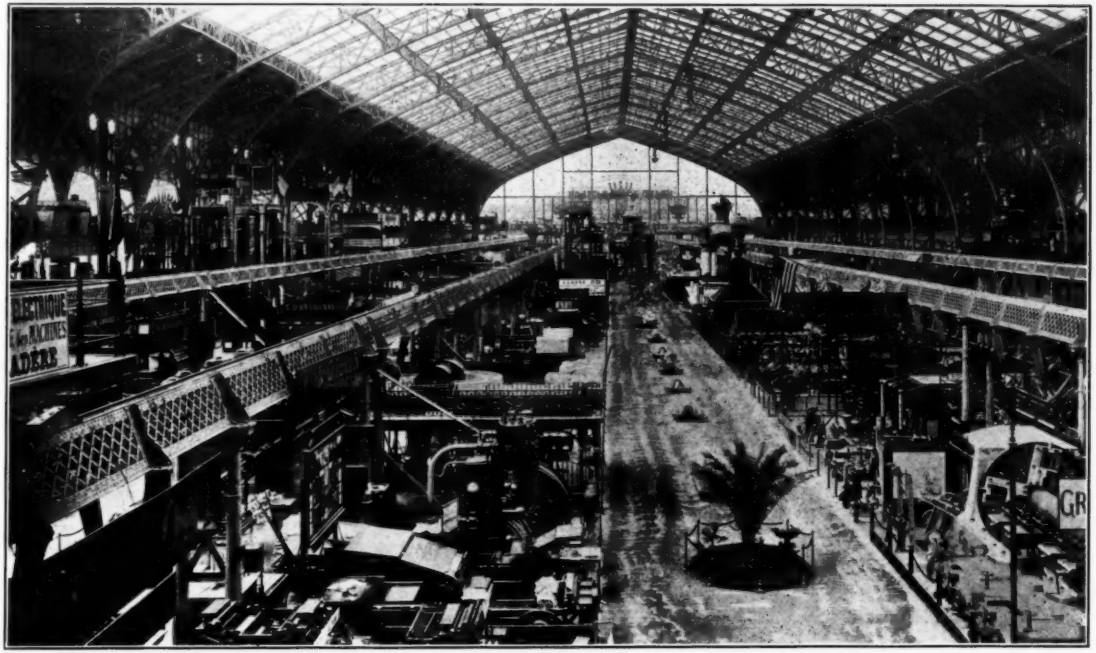
THE ENGINEERING ORGANISATION OF A GREAT EXPOSITION.

By Georges Caye.

Regarded subjectively, the great exposition affords a most striking example of works management on a colossal scale. Power generation, transmission, and application—mechanical transport of persons and materials—lighting, heating, and sanitation—above all, organisation and labour management—all must be ordered with the utmost available wisdom and forethought. Dr. Kerr and Prof. Aldrich have studied the mechanical features of the great expositions now open. M. Caye analyses the internal mechanism of the great Paris exposition itself.—THE EDITORS.

THE remarkable progress realised in all the varied branches of science and industry in the course of the nineteenth century has greatly extended the scope of the work of the engineer. The great increase in the part taken by machinery and the numerous transformations which have caused metal to be substituted for stone, have demanded a much wider range of knowledge than formerly, and continued to compel recourse to numerous expedients, calling in the exercise of much ingenuity and scientific ability. It is therefore altogether intelligible that in the organisation of such an undertaking as the recent exposition at Paris the engineer held a preponderating influence, and it is of interest to examine the various services rendered by the engineering profession, and the manner in which many difficulties were surmounted.

Let us recall the conditions of the organisation of the exposition. Its creation was ordered by the President of the Republic by a decree bearing the date of July 13, 1892; that is to say, hardly three years after the close of the exposition of 1889. This latter exposition had been so remarkably successful that it appeared difficult to think of anything better, while at the same time the desire of France to make the new exposition a worthy apotheosis of the close of the century



THE MACHINERY HALL AT THE PARIS EXPOSITION OF 1889.

This remarkable gallery, 110 metres wide and 420 metres long, remains as a memorial of the Exposition of 1889, and was used for various groups in 1900, the Salle des Fêtes, a large structure in itself, being erected entirely within it, and leaving much room to spare. Two electric travelling cranes of 60-feet span each traversed the entire length of the building, and were used for placing and removing exhibits. The end of one of these cranes is just visible at the left. These were, for the period, remarkable applications of electric driving.

demanded as much time as possible for the elaboration of plans and organisation. Early in 1893, therefore, the administration of the future exposition was started, being placed under the direction of a commissioner general, and to no one could this post have been better confided than to the man who filled it so admirably, M. Alfred Picard, inspector general of the Ponts et Chaussées, president of the section of public works of the Council of State, and secretary general of the Universal Exposition of 1889.

The various departments of the administration were sub-divided as follows:

Secretary General,
Direction of Finances,
Direction of Buildings, Parks, and Gardens,
Department of Roads,
General Direction of Exploitation,
Department of Bridges and Passages over the Seine,
Department of Claims.

In addition to these, there was instituted in connection with the office of the ministry of commerce and industry, a superior commission of the exposition, composed of about 150 members, and including in its membership the most eminent individuals in science, art, commerce, industry, politics, and administration.

Omitting further mention of the purely administrative departments, we shall discuss here the technical departments, properly so-called, in which members of the engineering profession have had to undertake the most difficult tasks, and as the issue showed, in a most efficient and successful manner.

As an example, attention may be called to the part played by engineers in the department of architecture, a department to which was entrusted the erection of buildings and pavilions covering 40 hectares (nearly 100 acres). This department, under the direction of M. Bouvard, director of architecture of the city of Paris, consisted of a great number of architects and engineers, and it is hardly possible to distinguish the one profession from the other here, since the erection of such buildings as were required by the exposition demanded the services of architects possessing practically the training and qualifications of engineers. In addition, the department of architecture commanded the services of a body composed exclusively of engineers.

All the large structures of the exposition really contained metallic skeletons of much constructive importance. The metal frameworks were obliged to support very heavy loads and at the same

time to span considerable openings. It was therefore deemed altogether prudent to provide a special engineering department, called the section of structural metal work, which was placed under the direction of MM. Résal and Alby, engineers of the department of Ponts et Chaussées, and designers of the remarkable bridge of Alexander III., a masterpiece of metallic construction which has already been described in THE ENGINEERING MAGAZINE by M. Jacques Boyer.*

All the designs for structural work were passed upon by the department, and critically examined before being approved. It was also the duty of the engineers of this service to inspect all the work of the various contractors, following the progress of the buildings step by step, making frequent tests of the actual material employed, watching the character of strength of the scaffolding, and maintaining a general critical supervision of the entire work, from the preparation of the foundations until the completed erection of the framework. All materials manufactured on the grounds were under careful inspection, both as to the quality of original material and to the method of preparation, this being notably the case in connection with the preparation of the concrete for the numerous examples of concrete-steel construction employed.

This unceasing inspection and control was not limited to the work directly executed by the administration of the exposition, but extended also over those structures erected by the public departments, as well as the foreign commissions and the various holders of private concessions. In a word, no building was permitted to be constructed within the limits of the exposition without having been inspected by the engineers of this special department.

The department of architecture had, therefore, to conduct all the tests upon which depended the definite acceptance of all the construction work, and when it is understood that this included, with the buildings erected by others than the exposition administration, fully 60 hectares (about 150 acres) of structures, and the supervision of workshops employing 20,000 workmen, the burden of the task will be appreciated. This commission was also entrusted with the design and construction of the wooden bridges which crossed the main thoroughfares intersecting the exposition at the bridges of the Invalides and the Alma. These structures demanded an exceptional degree of solidity in order to support the great crowds which daily surged over them passing to the Champ de Mars from the Invalides, and from the Champs Elysées to the Trocadero. They were therefore inspected

* See THE ENGINEERING MAGAZINE, Vol. XVII., May, 1899, page 214.

BAY OF MACHINERY HALL—CHICAGO, 1893.

Another view showing a second crane. These cranes were fitted with temporary floors during the Exhibition, and carried passengers and bands of music up and down the entire length of the building.

BAY OF MACHINERY HALL—CHICAGO, 1893.

The machinery building at the Chicago World's Fair was in three bays, and following the precedent set at Paris in 1889, electric travelling cranes were erected in each bay, these being exhibits of leading builders. By this means all exhibits were readily installed and removed, and the necessary handling during the Exhibition also accomplished.

with great care during construction, and subjected to numerous and severe tests before final acceptance.

The department of architecture also took charge of all details of construction with regard to a satisfactory degree of safety from fire, fireproof construction being demanded throughout.

The department of roads, entrusted to M. Defrance, director of the services of highways, sewers, water-supply, and lighting of the city of Paris, had in charge the entire system of roads outside of the buildings, parks, and gardens. This included the construction, operation, and removal of the numerous railways intended for the transport of materials of construction and of exhibits, as well as those used in connection with cranes and hoisting machinery.

To this department was also entrusted the arrangement and construction of the foot-ways and roads connecting the various parts of the exposition, including many stairways, quays, foot-bridges and highway bridges. This service included the water supply of the exposition, furnishing both potable and river water from the mains of the city of Paris, not only for drinking purposes but also for watering the plants, supplying exhibitors, and providing defense against fire. This water supply involved more than 1,000 service connections, of which 300 were of large size for supplying steam pumps. The necessity of providing against fire was most important, for, although the buildings themselves were of non-combustible materials, it was necessary to protect the great mass of exhibits with which they were filled.

The drainage of the exposition included an extensive special system of sewers, the flow of discharge water from the 110 hectares (272 acres) increasing daily from the beginning of the works until the close of the exposition. This sewage system was connected with the large collectors of the Paris system, and has been preserved intact for future service.

The department of roads also had charge of the lighting by gas of certain portions of the exposition, both within and without the buildings, in those portions in which electricity was not employed. An important portion of the work of this department lay in the examination of all propositions relating to railways and other installations intended for the transport of visitors within the precincts of the exposition. The projects finally adopted were the moving sidewalk and the electric railway. The latter involved some especially difficult problems, because the line was necessarily constructed partially overhead, partially on the surface, and partially underground. This demanded

a number of ingenious expedients which were successfully worked out in consultation by the engineers of the exposition and those of the company holding the concession.

Another delicate undertaking in the control of this department was the control of the thoroughfares parallel to the Seine, these being on each bank, parallel to the quays, and requiring to be kept open to the general public during the entire period of the exposition. Here it was found necessary to construct underground passages on the right bank at the Pont d'Iena, as well as on the side of the Champ de Mars, to enable that portion of the enclosed grounds of the exposition to be traversed. These required the construction of tunnels of more than 30 meters in length, in reinforced concrete.

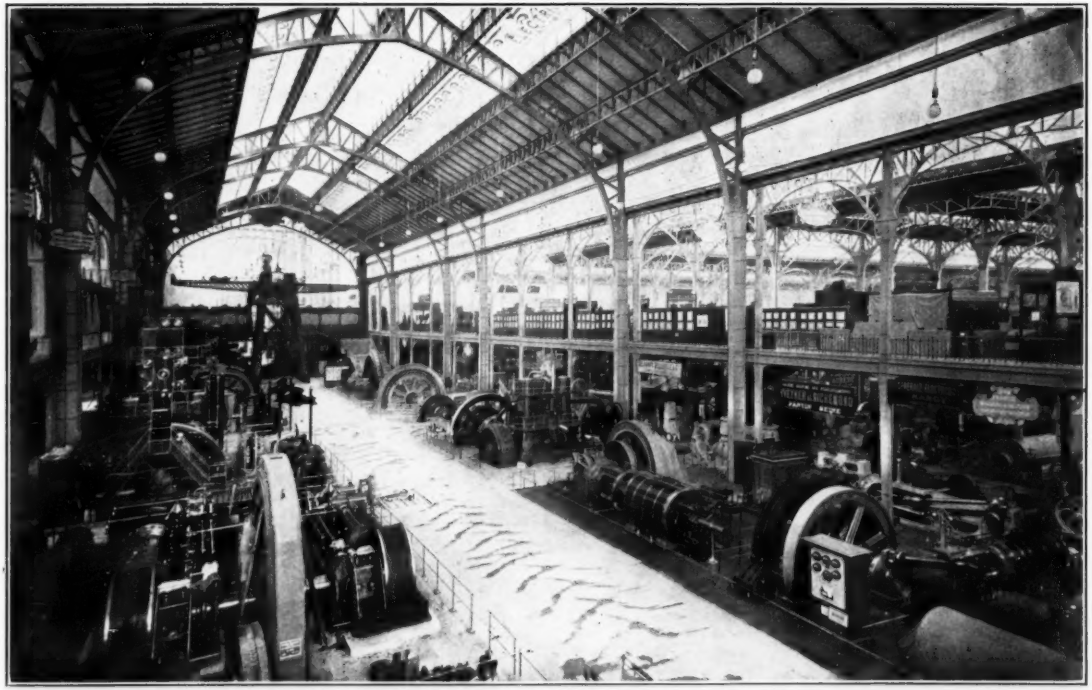
In this connection must be mentioned the bridges and temporary passages, which, at the exposition of 1900 occupied a position of particular importance, and the care of which was entrusted to MM. Résal and Lion, chief engineers of the Ponts et Chaussées.

The expositions of 1878 and 1889 occupied no space on the right bank of the Seine except in the palace and gardens of the Trocadéro connected directly with the Champ de Mars by the Pont d'Iena. The exposition of 1900, on the contrary, extended along both banks of the river, rendering it necessary to provide such communication between both sides as would permit a satisfactory circulation of the visitors.

The grounds of the exposition extended between the Pont de la Concorde and the Pont d'Iena, and the only two bridges crossing the Seine between these could not be utilised without a serious interruption to the regular traffic. It was therefore deemed advisable to construct temporary foot bridges by the sides of these two bridges, in addition to which the Pont d'Iena was provided with temporary sidewalks on each side. In addition to these an important temporary bridge was constructed across the river between the Pont d'Iena and the Pont des Invalides. The most important structure in the hands of this department, however, was the remarkable and beautiful Pont Alexandre III., to which reference has already been made.

The department of the administration entitled the general direction of administration was placed under the direction of M. Delaunay-Belleville, civil engineer, and honorary president of the chamber of commerce of Paris. M. Stephane Derville, former president of the Tribunal of Commerce of the Seine was made adjunct director general, having special charge of the French section.

The work of this department may be classed in two distinct categories: the administrative service and the technical service.



FRENCH END OF POWER-GENERATING SECTION—PARIS, 1900.

Nearly all the engines exhibited were connected directly to the electric generators, usually in large units, and the Exposition was notable for the absence of shafting and belting transmission. The cantilever crane seen in the distance travelled on rails laid beneath the flooring, and was used before and after the Exposition for handling exhibits.

The former included the formation of the departmental committees—the committee of admissions, the committee of admission of exhibitors, of installations, of distribution of space between exhibitors, and between nations, the formation of classes and groups (subject to the commissioner general), of control of receiving and delivery of exhibits, and of their protection, and of the constitution of juries and the distribution of awards.

The technical service, entirely confined to engineers of acknowledged reputation, had charge of the production and transmission of motive power. The system of classification adopted, being based upon the placing, for each industry, of the raw material, the process of manufacture, and the finished product in close proximity, made it no longer possible to follow the plan adopted in 1878 and 1889, of providing a great machinery hall for the motive power and the operating machinery. On the contrary, all the boilers and engines had to be placed in special galleries, the whole constituting a great central power house, from which energy could be distributed to all parts of the exposition. Under these conditions it was manifestly impossible to think of employing transmissions of shafting and belting, and recourse was had to electricity. In this respect the exposition became a most characteristic illustration of the progress made since 1889, showing as it did the important service rendered by the development of electric transmission of energy.

All the motive-power machines, therefore, appeared as generating sets in which the dynamos were mounted directly upon the engine shafts, either replacing or supplementing the fly wheels. The principal subdivisions of the technical department of the administration in this work were: the service of mechanical installations, having in charge the production of motive power; the service of electrical installations, controlling the distribution of current for electric power and lighting; and the service of handling, having in charge the erection and moving apparatus.

The service of mechanical installations was placed in charge of M. Ch. Bourdon, professor at the Ecole Centrale des Arts et Manufactures, he having also had charge of the mechanical and electrical service at the exposition of 1889. There was also a consulting commission, called the technical committee, consisting of sixty-one members, leaders in the scientific and industrial world, and presided over by M. Linder, inspector general of mines and former president of the superior council of mines. This committee was divided into three sections or sub-committees, upon boilers, engines, and mis-

cellaneous machinery; these being intrusted with the elaboration of the details involved in the production of 36,000 horse power by steam machinery. The steam boilers were required to furnish steam at a uniform pressure of 11 kilogrammes per square centimetre (156 pounds per square inch), at a rate not exceeding 600 kilogrammes of steam per square metre of grate per hour, (about 123 pounds per square foot of grate). The exhibitors were to receive, as compensation for the expense of installation, an indemnity of 1,500 francs per 1,000 kilogrammes of productive capacity per hour, in addition to the sum of 4fr. 45c. per 1,000 kilogrammes of steam produced. The subcommittee was entrusted with the examination of the various plans submitted by the exhibitors, with power to decide the evaporative capacity to be allotted to each boiler.

There were installed 92 boilers, of which 74 were multi-tubular, 4 semi-tubular, 6 Galloway, and 8 Cornish. In this connection it may be of interest to compare the advance made in the size and evaporative capacity of steam generators since 1878.

Exposition.	No. of Boilers.	Daily Evaporative Capacity.
1878.....	19	219,450 kilogrammes
1889.....	30	382,205 " "
1900.....	92	1,500,000 " "

The quantity of combustible consumed during the exposition reached 200 metric tons per day, and to enable this amount to be handled there were installed two tracks connecting with the railway station of the Champ de Mars, and extending throughout the length of the two galleries in which the boilers were placed. Each morning the cars brought in the supply of coal for the day and removed the ashes and cinders of the previous day, the whole occupying but a brief space of time. The service of mechanical installations also had charge of the design and construction of the flues by which the gases of combustion were conveyed to the chimneys. The two great monumental chimneys provided, one for each gallery of boilers, were constructed with especial reference to the removal of the gases without the production of any objectionable effects in the neighbourhood. It was also essential that the chimneys should harmonise in appearance with the structures on the Champ de Mars, and the final designs were selected as the result of a competition in which eighteen projects were submitted.

Having thus provided for the installation of the boilers and the generation of steam, the distribution to the various engines demanded attention; and this problem involved the design of an important system of underground passages. The entire system of underground

galleries formed a total of 1,500 metres in length, the passages being 2.7 metres high and 2.6 metres wide, providing for the passage of 1,500,000 kilogrammes of steam at a pressure of 10 kilogrammes per square centimetre (142 pounds per square inch) and 35,000 cubic metres (1,236,000 cubic feet) of water per day. The steam was carried in mains to which the feed pipes of the engines were directly connected. Since the public were admitted freely to the boiler houses, walking directly upon the covering of the underground passages, it was necessary to take the greatest precautions that no accidents should occur.

The installation of the generating sets was conducted under the joint supervision of the services of mechanical and of electrical installations, the latter being under the direction of M. R. V. Picou, president of the Société Internationale des Electriciens, and maitre de conferences at the Ecole Nationale des Ponts et Chaussées. In addition there was an electrotechnical committee, consisting of forty-two members, presided over by M. Mascart, Member of the Institute, this committee having charge, in conjunction with the sub-committee on engines, of the various questions arising in connection with the production, distribution, and utilisation of electrical energy. These two committees selected MM. Hirsch and Potier to examine the proposed projects in detail.

The generating sets adopted were arranged in two galleries, parallel to those containing the boilers, one gallery being reserved for the French exhibits and the other for those of foreign countries. As with the boilers, it is interesting to compare the number and size of engines with those at previous expositions:

Exposition.	No. of Engines.	Total H. P.	Average H. P. per Engine.
1878	41	2,533	62
1889	32	5,320	166
1900	37	36,085	975

At the exposition of 1900, seventeen generating sets, representing a total of 13,200 horse power, produced continuous current, while the balance generated alternating and three-phase currents. As in the case of the boilers, the constructors of the generating sets received indemnities for the cost of installation and the expense of operation. The amount paid out by the administration for this purpose to the French and foreign exhibitors attained the sum of 800,000 francs.

The distribution of the electrical energy was entirely under the direction of M. Picou. This was a delicate and difficult problem, especially in view of the variety of motors employed and the different

kinds of current generated. The continuous current, having a low voltage, was necessarily used near the place of its generation. It was therefore employed for the transmission of energy and for illumination within the limits of the Champ de Mars, at a pressure of 220 volts, and at the Invalides for motive power only at a pressure of 500 volts.

In the case of the alternating currents, it was deemed advisable to arrange the service in such a manner as to permit any motor, in case of accident, to be replaced at once by another. For this purpose the exposition was divided into sections, each section being supplied by a special current corresponding to a group of generators having the same general characteristics, and producing currents of the same character, voltage, and frequency.

As the exposition was open in the evenings, the electric lighting became a matter of importance, the total radiation of the electric lamps representing about 7,000,000 candles.

The service of handling was placed in charge of MM. Guyenet and Ringuier, and included the moving and placing of the exhibits, as well as the materials of construction. It was found necessary to establish a complete system of railway tracks upon the exposition grounds, the exhibits arriving both by railway and by boat. Powerful hoisting devices were necessary for handling the heavy masses included among the exhibits in the sections of machinery and metallurgy. The latter section was provided with two electric cranes of 25-tons capacity each, capable of being operated singly or together. A temporary flooring was placed in the building for the metallurgical exhibits on the Champ de Mars, and although this flooring was very heavy and strong, the weight of some of the exhibits was so great as to require it to be especially strengthened in certain parts to carry the great local load.

The heavy exhibits arriving by water were unloaded by means of powerful cranes on the Quai d'Orsay, one at the Pont d'Iena being of 45-tons capacity, the other at the Pont d'Alma of 30-tons, the latter being operated by a petroleum motor. In the galleries containing the engines and electric generators were two powerful hoisting machines, a Titan crane of 45-tons capacity being in the French section, and an electric gantry of 25-tons in the foreign section. Besides these large machines many smaller hoisting machines of various kinds were scattered throughout the exposition. An idea of the importance of the service of handling may be obtained when it is understood that the heavy pieces in the department of metallurgy alone represented a total

of 75,000 tons, of which 40,000 tons were delivered by railway and the remainder upon trucks.

It may be remarked that this service was especially well conducted, being the only one which was ready at the date fixed for the opening of the exposition, and unlike the other departments having done no night work.

The service of handling, in addition to the duties already described, took charge of the numerous elevators, travelling stairways, etc., connecting the ground floor with the numerous overhead galleries.

Finally we may mention the service of hydraulic installations, in charge of M. Meunier, and charged with maintaining a supply of water for the Chateau d'Eau and for the feeding of the boilers. The necessary supply was taken from the Seine below the Pont d'Iena and delivered by an important pumping station. After being used the water was returned to the river, this involving a double system of pipes, which, together with the pressure of water offered a considerable resistance to be overcome.

Such was the broad outline of the service of an exposition involving the services of fully 5,000 men.

All these various services, instead of being scattered over the exposition, as in 1889, were grouped in a special building, erected on ground temporarily acquired near the exposition, where formerly had stood the imperial stables. This building, covering an area of 6,124 square metres, was designed by M. Deglane, the architect of the large palace of the Champs Elysées, who acquitted himself most creditably of this thankless task, for which the meagre sum of 400,000 francs only was allowed. This grouping of the headquarters of the services presented many advantages, resulting in a material saving of time in the communication between the various departments, and above all, in producing a homogeneity most beneficial to the progress of the work.

In concluding, we may be permitted to render a final tribute to the many eminent men, who, in spite of the inevitable misunderstandings and difficulties of such a vast undertaking, succeeded in giving us such a grandiose and at the same time fairy-like exposition; a veritable apotheosis of the century which has closed and at the same time a brilliant dawn of the century just opening.

AMERICAN MACHINE-SHOP PRACTICE FROM A GERMAN VIEW-POINT.

By Peter Lüders.

Mr. Lüders' estimate of American practice represents the conclusions of a thoroughly practical man, master of the machinery and tool-making trade in Germany and minutely familiar with its technical and economic aspects. His American experience was gained during an extensive tour of the United States in a semi-official capacity. An unprejudiced view of this sort, given by an outsider, is highly valuable at a time when American competition in European markets is attracting so much attention. Mr. Lüders' second paper, treating specially of standardisation, will appear in our next issue.—THE EDITORS

N the papers upon "Machine-Shop Management in Europe and America," published in THE ENGINEERING MAGAZINE, 1899, Mr. H. F. L. Orcutt, referring to the large amount of American machinery purchased during recent years by European and especially by German manufacturers, says:

"The large quantity of American machinery now being sent to European countries indicates that there is something in American machine-tool practice and design which is desirable to European manufacturers, and cannot be secured from their own makers of machinery. Why is it that the European manufacturer is buying so largely from America? How is it that the American machine-tool maker can send machinery abroad, pay freight and duty, and compete with the European maker? It is important for both sides to understand the situation; on the one hand, for the European to select that which is good in American practice, and to adopt it as far as possible, on the other hand, for the American maker of machinery to know where his practice differs from the European, so that he may adapt his methods as far as desirable to European demands."

"It is important to understand the situation." Nothing seems to be easier to get than this understanding, and very likely most of the engineers on both sides will consider it to be so. But anyone who has been once in America and found sufficient time and opportunity to become familiar with American machine-shop practice and American manufacturing conditions, will not hesitate to say that there is hardly any-

thing more difficult than the acquirement of a real understanding of the situation on both sides.

The problem is a much debated one, and a great number of writers have undertaken to state the differences between the works and their equipment in Europe and in America, and to show the rules for the general management or the system of an American machine shop, and have advised the selection and adoption or the simple copying of that which is good in the practice of one or the other of the two countries. But the why and the wherefore which brought about these differences are left quite unconsidered, certainly so far as employer and employee, that means as engineer and workmen, are concerned. And so if all these points of physical difference be noted as clearly as possible, not only for a machine-tool factory as Mr. H. L. F. Orcutt does in the paper mentioned above, but for every works no matter in what line—no branch left out, every department mentioned with all its details—there will nevertheless still be left unconsidered many features far more important than all these counted. These deeper-lying matters may seem to have no connection at all with machine-shop management or the manufacturing system itself, with the increasing or decreasing demand for the manufactured articles, but they are there and they must be taken into careful consideration if a good understanding of the situation is to be reached. The first study, therefore, may be of the mechanical engineer and the prominent part he has played during the last few years of enormous progress.

Not only by the new machine tools or the use of time- and labour-saving machinery, not alone by the separation of the different departments or the employment of low-wage workers on the one hand and of a number of highly skilled foremen or tool-makers on the other hand, nor yet by the erection of well and hygienically designed works nor by the immense advertisement business done all over the world, have American works and their products been brought to the perfection they have reached now. No; all these things are themselves only consequences, and by no means the first reason that American machinery has become an everywhere-demanded product. The question how this result has recently been achieved is a very important one for the whole industrial world.

Before the Americans undertook to understand the situation on the other side of the ocean, they began by understanding the situation at home thoroughly. They recognised that a real success would only be obtainable where theory and practice—or, even better, engineer and workmen—would work together hand-in-hand. They learned that

there could be no separation at all of these two factors, and that the opportunity for the exercise of judgment was in determining where and how far practical knowledge needs the grasp of theory to design a good and universally demanded product. But the Americans did not stop at this point; they let the deed instantaneously follow up the thought. The engineer ceased to tower hundreds of yards above the workman, thinking his own knowledge much superior to the man beneath him. He recognised that his work would be only half if he did not co-operate with the workman, and so he tried to become the head for him. The workman then gave the hands. Thus theory and practice, engineer and workman, idea and realisation, came together and the result was what we see and study now in America and what the most of the German engineers like to call, with absolute non-comprehension of the situation, the result of the *"Amerikanische-Ingenieur-geschicklichkeit."*

I believe this unity of the engineer and the workman to be the most important part of the whole explanation how the American machinery trade could develop so marvellously in such a short time as three or four years. I shall endeavour to give in this paper an idea of how this could be, that is, how engineer and workman in drawing-room and machine-shop must bring together their ability, their knowledge, their experiences, to create the best possible results—commercial, technical and practical—as is now the case in America.

The commencement, therefore, is the absolutely free intercourse of ideas and experiences throughout the staff in general, and further between the chief engineer and his draughtsman, which is never hampered by any professional jealousy. The chief engineer certainly takes the main responsibility for all construction work, and he would lose his place as the consequence of any mistake at all important to his firm. But he does not fear this responsibility, feeling it to be the only thing that can give him real interest in his work, and knowing that his greatest help and his best protection against any possible failure will be to give a share of his responsibility to his draughtsmen, that is, to interest these men personally in the work given to them. Therefore he proceeds to teach his men, to show them how to get out the best, the cheapest, and at the same time the most economical constructions. Let them thus learn how he works, let them follow up his ideas and use them later on wherever they like; to-day he is working for this firm, these men are given to him to help him, and he could do nothing more foolish than to go his own way, careless of all others in his office, believing them much too narrow-minded to understand him or think-

ing himself far more clear-headed than all his men together. He knows that his work can be a successful one only if he understands thoroughly how to use his men's brains always and everywhere, *and that policy he never forgets.* Some people will certainly say these ideas are just as selfish as every American is. May be; but the draughting room is not the place to dispute about feelings and other things of that kind; it is the place where the most important part is done to secure a success for the whole works by increasing the capacity and application of every constructed machine and by producing every day work more fitted to prevail in the world-wide competition. The chief engineer may be as clever as possible, as broad-minded as imaginable, but he will never be a *good* chief-engineer if he does not take the greatest care for every detail of his own constructions as well as those of his draughtsmen and does not force his men as well as himself always to find, for every construction, the simplest method of production. But if that is to be obtained, it is absolutely necessary, as already stated, on the other hand, to have the hearty co-operation of his men, on the other hand to specialise himself.

These two facts the Americans have fully recognised and the result shows that they know how to get the best out of their recognition. The best and ablest men and the largest manufacturing concerns confine themselves to the study of one class of machinery only, trying to bring this to the highest grade of accuracy and application, altering and modifying drawings and patterns over and over again until the best, the cheapest, and the most economical machine, for the builder as well as for the buyer, has been secured. And the end of all this work, of the enormous amount of energy and capital employed therein, is the system of specialisation and standardisation, which now generally characterises the entire American industry.

German engineers as a rule do not believe in this kind of friendly co-operation, relations of the chief engineer toward his draughtsmen in respect of knowledge and standing being mostly the same as those of the officer to his common soldiers. Still less do they study American specialisation and standardisation, generally believing it necessary and useful for every one else except for themselves. Certainly no one who knows Germany and America and who has any understanding whatever of the situation on both sides of the ocean can advise German concerns to proceed immediately to specialise their business as far as the Americans have done, particularly if he cannot give them at the same time an understanding of the very great importance of free intercourse and unhampered co-operation between the chief

engineer and his men. But before that would be possible a complete revolution of nearly everything connected with the German engineer and engineering business would be necessary. At present nearly every one of them believes himself worth nothing if he does not figure out a new construction, no matter for what kind of machinery. He must have his patents, he has to show the world that he is a man who does not depend upon the knowledge of all his forefathers, and he must be as much as possible an all-around engineer. And this conception makes it possible for an engineer to advertise himself, as I actually saw lately in a German technical paper, as "a most able man not only for general steam-engine constructing and manufacturing business and for the building of brass and every other kind of foundry, but also for the construction of flour mills, grain elevators, storage houses, steam brick kilns, pottery works, apparatus and fixtures for breweries, beer cellars and beer filters of the latest style, mills for grinding gypsum and cement, hydraulic presses and high-pressure pumps, bar pumps, air compressors, cranes, elevators, and agricultural machinery." He must have been an "all-around engineer," but not one who could give any really good advice in any special case, even in one of the lines he thought himself especially fitted for.

It may be that under this kind of working there have been brought forth a number of good and theoretically fine constructions, but that is of very little value compared with the results which could have been obtained if most of these men would have used their ability to perfect preceding work instead of ignoring the experiences of all their forerunners. So they create the most complicated constructions, maybe to spare one-quarter of a pound of coal under the boiler or steam in the engine, making their firms therefore pay out enormous sums of money, never realising that the best construction is useless if it does not mean at the same time improvement in competitive position. But if German engineers would recognise that fact they would have the same success with their works as has been realised by any of the great American firms who have attained international reputation. At every one of these places there is specialisation, but in moderation—just enough to get the best of everything, but not necessarily so much that only one kind of machinery is built.

Cramp's works I believe to be the nearest approach in general character to the so-called German steam-engine works, but I think far better managed in many points. This establishment shows that between keeping to the old style of doing business and the latest and most extravagant kind of American specialised works there are many

good means worthy of adoption. If these are considered and employed at the right place, the result would prove very soon that the best German engineers and manufacturers can do, to get out work a good deal cheaper, more uniform, and with quicker deliveries, would be to follow up some of the methods used with great success in these American shops. So the engineer and manufacturer could help to bring about quite a new era in the German machine business. But unfortunately it does not depend only upon them.

There is still one factor more, and to modify that the change would have to be far greater than for the engineer. If the engineer believes himself to be the only one who knows anything about machines, the man who intends to order a machine knows far more about it. He will not come and tell the manufacturer that he needs an engine for so many horse power and for such a kind of work. No; he writes a complete book called *"Bedingungen,"* and this book serves only to cripple to the greatest extent energy and enterprise, compelling the manufacturer constantly to follow the caprice of one customer after another; he has no opportunity whatever even to classify and utilise the informations that he picks up from experience as he goes along, as Sir Benjamin C. Browne says in his articles in THE ENGINEERING MAGAZINE on "Standardising in Engineering Construction."*

So far I have considered only the hearty co-operation of engineer and workmen, or the union of theory and practice, as a reason for the enormous progress the American machinery trade has made during the last few years. But besides that cause there are a great number of others, not less important or interesting, which brought that state about. These may all be taken together under the headings of "specialisation and standardisation."

Nearly everything the German engineer will find new and interesting when visiting American works can be placed under this heading, these two words and their meaning containing the summary of all that American ingenuity has accomplished during recent years. And the treatment of these two headings will, on the one hand, show most clearly where American engineers and manufacturers have manifested their excellent comprehension of the world's needs and requirements, and, on the other hand, will let the German engineer and manufacturer discern where he may learn something for his own profit. The detailed exposition of the system of specialisation and standardisation as it affects the practical conduct of the works will be taken up in a succeeding article.

* THE ENGINEERING MAGAZINE, Oct., Nov., Dec., 1899.

THE CHOICE OF AN ELECTRIC-POWER DISTRIBUTION SYSTEM IN FACTORIES.

By P. R. Moses.

The views from the Glasgow and Buffalo Expositions shown in the first part of this Magazine, as well as the illustrations taken from the Paris Exposition of 1900, suggest the wide extent to which electricity has supplanted wholly mechanical systems of power application. Mr. Moses assumes as his starting point that only the manner of its use remains open to debate. Not the least interesting point he makes is that the increased efficiency of the use of human energy secured by electric driving is really the main cause of its success. He makes an able plea for the system which he favors, but admits freely that other methods have strong advocates. The Magazine will be glad to afford to any debatant of the question an equally full opportunity to argue his view of the case.—THE EDITORS.

THE question of the advisability of the electrical transmission of power in factories and mills may be regarded as decided in the affirmative, and with the exception of some machines essentially compressing or reciprocating in their action, such as riveters or hydraulic presses, the electric motor operates the machine to be driven directly, through belt, gear, or shaft, without the interposition of any fluid or gas capable of storing power. Until the beginning of the present boom, however, electricity had a hard struggle to hold its own against compressed air and other methods of transmission having the "talking point," as it may be properly called, of storage of energy. In fact, until Mr. Gano S. Dunn and some others showed how small the question of cost of power was compared to its ease of application and regulation; until manufacturers and mill owners had been forced, by the immense influx of orders involving immediate addition and changes to existing plants, to realize the advantages of a system absolutely flexible in its character as to speed of operation, location, or capacity for enlargement; until the electric motor had become, through many years experimenting by the most skilful engineers of the country and immense investments of capital, a standard manufactured article reliable and replaceable in all its parts; until, finally, the money was available with which to install the electrical apparatus on a proper scale—the electrical method of power transmission was fighting for suprem-

acy. Now that it has found its place at the top, its advocates, like the members of the ancient church, have fallen upon each other, and the cries of alternating *versus* direct, or of 500-volt *versus* 250 or 125-volt transmission, are as strong and enthusiastic as were those of the air and kinetic power advocates in former times.

This question has been brought up more frequently and ardently within the last two years than before, owing to the increased perfection of the alternating, or to be more exact, the polyphase alternating, motors and systems, caused by the enormous development of long-distance-transmission plants, and the desire for uniformity coupled with the excessive competition in direct-current apparatus, obliging the large electric companies to look for more exclusive fields. To these causes chiefly may be ascribed the rise and the development of the two- and three-phase alternating-current generator, motor, and system; a rise which has been almost as rapid as that of the trolley-car or bicycle industry.

It is purposed in this article to discuss the merits and demerits of this system in its application to mills, factories, and buildings, and also to discuss another important general question, viz., the question of the best electrical pressure at which to transmit the power. There is not quite as much discussion of this point as of the other, nor is the question one of as great importance, but the cause of the decision as to advisable pressure has a large bearing on the advisable current and is therefore interesting. Before entering into details it will be well to review the reasons for the success of electric transmission. In the first place, electric motors supplanted small steam engines for driving groups of machines through counter shafts, on account of the absence of steam pipes, cleanliness, noiseless operation, superior speed, regulation, and higher efficiency. These were the first causes; after these, the smaller floor space occupied, the capacity for protection of machinery, and the ease of removal were all recognized as material advantages.

In the second place, the electric motor for individual machines has supplanted, notwithstanding a higher first cost, the group drive with overhead belts and shafting, except where a number of very small machines are driven, because it allows individual and gradual speed regulation of the machines, reduces the number of links liable to fail in the chain of power transmission, gives good light, permits the extended use of overhead travelers or cranes, and allows each machine to be set in the best available position at any angle or, as is the case in some steel-construction works, allows the machine to be set upon a turn

table. In other words, it makes each machine an independent entity provided with a motor suited to its individual needs. It is this independence, I am informed, that has led the United States Government to provide every machine in its printing-office addition with an individual motor, extending this practice down to small sewing and ruling machines requiring but a fraction of a horse power to drive them; and this has been done, although the group drive for the small machines would have been more efficient, and probably less bothersome to look after and very much less in first cost.

The advantage, and one beside which the disadvantages sink into insignificance, lies in the fact that each machine can be driven at the speed best suited to its operator and to the work it is doing. Besides this, the ability to place the small machines at varying angles according to their location in respect to windows is important, as is also the facility of removal, should a rush of other work require the space. It may be said that the increased efficiency of use of the energy contained in steam, which was the main argument advanced for the adoption of electric group drive, has become insignificant compared to the increased efficiency of the use of human energy obtained by the direct-connected electric motor. Having these reasons for the adoption of electric transmission clearly in mind, the question of alternating *versus* direct-current transmission may be intelligently discussed. The best system in general will be that which will be free from breakdown, able to stand hard usage and frequent sudden overloads, simple and safe to handle, with parts standard and available. It should be uniform and applicable to all the requirements liable to arise in the work contemplated, the speed of the motors should be variable at will of the operator, and in some cases, like hoisting, should vary inversely with the load to prevent undue use of power. The motors should start with small currents and should have high efficiencies at average loads. The first cost should be as low as possible and the number of parts a minimum.

The alternating two- or three-phase system at low pressure (500 to 220 volts) meets the first few conditions slightly better than the direct-current system of the same voltages. This system consists of a polyphase generator composed of a stationary and a revolving part, an exciter, sometimes revolving on shaft, sometimes belted to shaft, for delivering the current required to magnetize the fields, a system of distributing wires and motors frequently built without brushes, but sometimes, where adjustable speed and good dynamo regulation are required, with brushes and collector rings. The system is simpler than

the direct-current system, in that no current has to be delivered to any moving part of the motors. In the direct-current system, current must be delivered to the rotating armatures of the motors through brushes of carbon and commutators made up of copper bars held firmly, clamped by a collar, with mica between the bars and between the bars and collar. This commutator is the chief difference between the motors of the polyphase alternating systems and the motors of the direct-current systems. The connections to the commutator and the commutator itself are the only parts of the motors in which trouble is liable to arise, with careful construction, and, although probably a hundred thousand are in use daily and the manufacture has been carefully studied, trouble does arise; generally on account of accumulation of grease or dirt, allowing the current to jump from the copper bars to the iron frame of the machines, or from breaking of connections between winding and commutator lugs, caused by frequent stopping and starting combined with overheating and slow cooling. This alternation of heating and cooling causes the copper to become brittle and, unless the connections are made flexible, to break off.

The advantages of simplicity, durability, and freedom from breakdown, therefore, are, with the alternating polyphase motors, more especially of the brushless type; but unfortunately for the polyphase system at the present day, all the other requirements are much more easily and better met by the direct-current motor.

The alternating-current system is not yet fully standardized, but is constantly being perfected and broadened in its scope. Its parts are obtainable from but two or three first-class companies; it is not applicable yet to charging storage batteries, to railroad work, or to hoisting, although it has been used for both the last; the speed of motors is not adjustable unless the brush and collector-ring type is used; the starting currents under load are large, causing more or less fluctuation in lights; and the first cost of dynamos and motors is between 25 per cent. and 35 per cent. higher than that of direct-current apparatus of the same capacity. Therefore, unless the value of adjustable speeds, 25 per cent. less first cost, higher average efficiency, etc., are balanced by the possibility of commutator troubles, the direct-current system is at present preferable and advisable for ordinary cases of factory transmission. In such cases the polyphase alternating current's value is confined to the transmission of power from distant sources at higher pressures. In special cases the alternating-current system may prove advisable even for medium distances. One of these instances is in hat, candy, or similar factories where electricity is largely used for heating

as well as for power and for light; the ease with which an alternating current can be transformed—*i. e.*, small quantity at high pressure changed to large quantity at low pressure, or *vice versa*—gives this system the preference, as quantity and not pressure is the essential feature of electric heating. Works where naphtha or other explosive gas is used require a sparkless motor, and the alternating motor is the only one fitted for this use. Machine shops with a number of small scattered machine tools may be better suited by one system or the other, depending on the question as to the advisability of direct connection of tools, the amount of probable overload, and the question of speed variation. In mills, large machine shops, and factories of all kinds where the power to transform is not valuable, there is no benefit to be derived from the polyphase current sufficient to offset the disadvantages mentioned.

As to the best pressure to be used for transmitting direct current, the answer cannot be so definite. The advantages of a high transmitting pressure, such as 440 to 500 volts, are low first cost and small bulk of wiring, switches, and controlling apparatus. The disadvantages are increased liability to ground, danger of shock, increased number and decreased size of field armature wires and of commutator bars. The liability to ground may be guarded against in the construction, but the other difficulties are inherent and are sufficiently objectionable to make the 500-volt motor and system inadvisable, except for such purposes as electric railroads where power has to be transmitted a long distance. The 220 to 250-volt motor has only half as many commutator segments, armature conductors and connections as the 500-volt motor; and the 110 to 125-volt motor but one-quarter the number. The sizes of these parts increase in proportion to the decrease in number; hence, the lower the voltage of a motor, the more substantial and the stronger mechanically. The lower voltage offers the advantage, too, of decreased tendency of the current to jump to the frame or from one wire to another. The winding of the fields of the 120-volt motor is made up of less than one-half the number of turns used in the 240-volt motor, and while the wire has twice the area, it does not occupy twice the space; on this account the field coils of the low-voltage motor do not heat as much as the higher-voltage motor. On the other hand the resistances used to control the speed and starting current, the switches, fuses, and the wiring are much larger and heavier for the 120-volt motor than for the 240-volt motor, and for motors of large size this is a decided disadvantage, as it interferes with ease of regulation and control and increases the first cost.

For small motors, 5 to 50 horse power, for transmission over short distances (from 200 to 400 feet), and for fluctuating work, such as elevators, presses, cranes, punches, etc., the 125-volt two-wire system seems preferable. For large motors, transmission over comparatively long distances, or for steady work, where mechanical strength is not essential and where the motor will receive attention, as in silk mills, carpet works, etc., or for work where minimum weight and size are important, the 240-volt system, or one of higher pressure, is usually the best fitted for the purpose.

The lighting of the factory or mill has an important bearing on the choice of pressure and system. At 240 volts, arc lights do not give thoroughly satisfactory results, even when coupled together in series, and the incandescent light at this pressure uses one-third more current, costs one-third more to buy and to operate, and has a shorter life than the 120-volt lamp. It is my practice, therefore, no matter what pressure is used on the motors, to use 110 to 125 volts for lighting. Where the motors operate at 125 volts or less and are of small size, the lights can be taken off the same wires as the power without annoying fluctuation, provided the mains are correctly designed. Where the motors are large and operate at 125 volts or less, a separate two-wire circuit for lighting is all that is necessary. Where the motors operate at 220 to 240 volts, there are several methods of getting 110 to 120 volts for lighting. The one generally used up to the last few years, and still very largely adopted, was to run two dynamos, each generating a pressure of 120 volts, in series, and let these feed a three-wire system, in the same way as the Edison Company adopt for city distribution. The same result is obtained by using one dynamo with two commutators. Another method, which seems preferable for factories where the load can be closely balanced, uses the three-wire system of distribution, but the dynamos operate at 220 to 240 volts, and the current for the middle wire of the three-wire system is supplied by a small motor-dynamo, the capacity of which need seldom be over 5 per cent. of that of the main dynamos, as it only counterbalances the amount of unbalancing of the three-wire system. This system allows the plant to have fewer units and to use each unit to its best advantage.

A method recently adopted, and installed, I think, for the first time in the United States in the South Station of Boston, was originally invented by Dobrowolsky of the Allegemeine Electricitäts Gesellschaft, about twelve years ago, and has a great deal to recommend it, and will, I am confident, be largely used as it becomes better known. The three-wire system is again employed with dynamos operating at 220 to 240

volts, but in this case no auxiliary moving apparatus is necessary. The current for the middle wire is supplied from points in the winding, midway between the brushes of the dynamos themselves, through collector rings, the same as those used for alternating-current generators. As the current in any dynamo is alternating originally, the current for the neutral wire is supplied first from one side of the dynamo and then from the other, keeping the armature circuits balanced and supplying current to the neutral wire. This method will work and will supply the current required, in practice, by the unbalancing of the lighting circuits. There are, of course, many other ways of supplying the lights, and in some instances it may be advisable to run a separate engine and dynamo for lighting alone, but this is not generally the case.

Where polyphase induction motors are used, low-voltage (125-volt) motors offer no material advantage to offset the disadvantage of heavy wiring and controlling apparatus. If the motors are small and in such a position as to place the employees in danger of contact, a voltage of 220 to 250 should be used; otherwise a voltage of 500 is usually employed. Larger motors are run at from 500 to 3,000 volts, depending upon circumstances. The question of frequency, *i. e.*, the number of alternations per second, in polyphase work is of greater importance than that of voltage. Here again there is a conflict between first cost and best operation. Generators and transformers are smaller and cheaper at a frequency of 120 cycles per second than they would be with a frequency of 60 cycles per second, but the losses and troubles from induction would be much greater and the regulation with a heavy motor load would be bad. On the other hand, a frequency of 40 cycles or less per second gives unsatisfactory lighting service, and the motors and transformers are somewhat heavier and more expensive. A frequency of about 60 cycles per second gives good lighting results, both arc and incandescent, and, as the induction effects are not excessive, permits fair regulation. The lighting circuits will, of course, be separate from the power, and if the lighting is but a small proportion of the load it may be taken from one pair of circuits only, thus simplifying the wiring and transformers.

The number of phases to use, whether two or three, is another point of difference; the two-phase dynamo and motor connections are somewhat simpler, while the weight of copper is less for the three-phase system. In factory and mill work, where the question of transformers is of no importance, the three-phase system has a slight advantage, but of so little importance as to be overbalanced by a possible question of delivery or machines in stock.

Questions as to the use of motors able to start under heavy load, or motors with or without brushes and with high or low power factors and similar technical points, may be left out of this discussion as they must be settled for each plant according to the conditions. In general, the brushless motor in a factory plant, while it avoids trouble at the motor, creates trouble in the rest of the system by disturbing the regulation, and gradual speed regulation with this type is impossible. With the brush and collector-ring type the system is subjected to no more serious disturbance than it would be with the direct-current motor, and speed regulation is easily obtained.

It is my opinion that at present prices the 125-volt direct-current two-wire system is the preferable one in most instances, and little or no trouble with the motors or dynamos is experienced at this voltage. Where the distance through which the power is to be transmitted is such as to make the cost of wires for carrying the current too great, the 240-volt direct-current three-wire system should be used. Where there are special features, such as those heretofore mentioned, or where the power is transmitted a distance too great for the 240-volt direct-current system, the three-phase alternating-current system, 60 to 70 cycles per minute, becomes necessary and gives thoroughly satisfactory results.

The greatest drawback to the alternating-current system today is its excessive cost which brings no equivalent advantage. In the course of a few years this difference will disappear, and the system will probably be used for all situations demanding a higher pressure than 125 volts.

THE GOLD MINES OF SIBERIA.

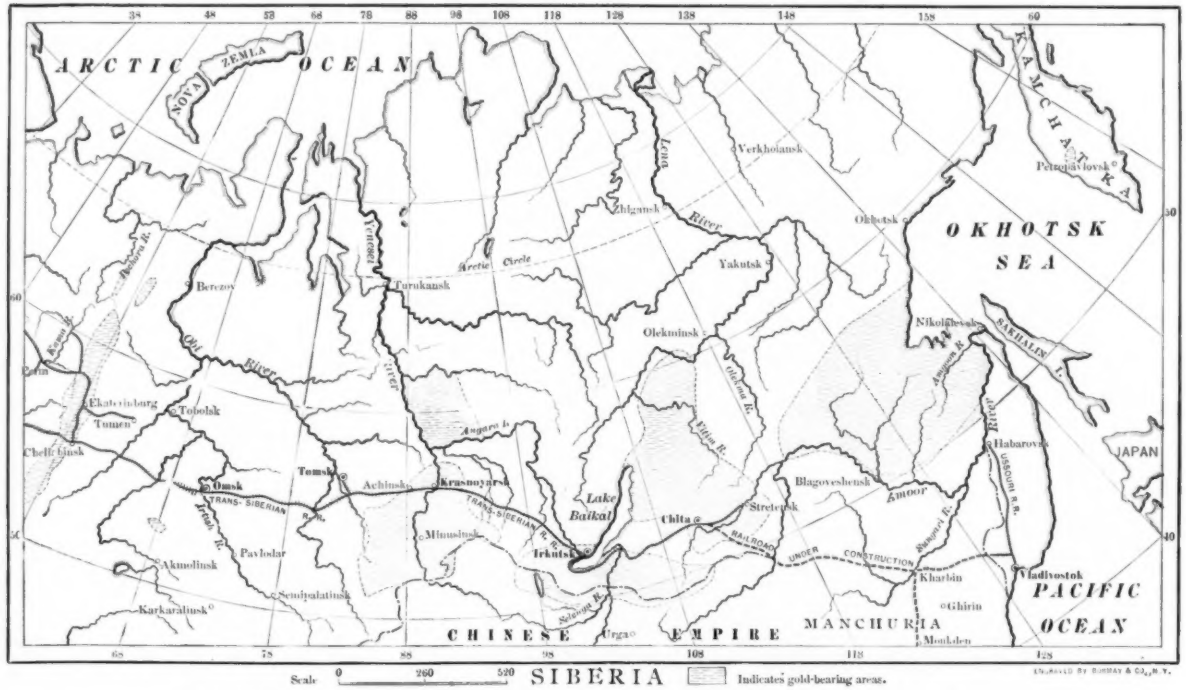
By Chester Wells Purington.

Within very recent years only has Russia begun to attract even a fraction of the interest her wonderful engineering and industrial possibilities deserve. How keen that newly awakened interest is, is proved by the remarkable attention given to Mr. Ford's series on "Engineering Opportunities in the Russian Empire," recently concluded in this Magazine. Mr. Purington takes up another side of the subject and gives a startling—almost sensational—view of the enormous gold wealth in Siberia waiting only for intelligent development. And this striking account is by a man thoroughly familiar with the field from four professional journeys. The illustrations accompanying the paper are from photographs by the author and by Lewis B. Brown.—THE EDITORS.

Cossack Miners of the Urals.

TWENTY-FIVE millions of dollars in gold are annually produced and put into circulation by the miners who operate in the little-known regions of eastern Russia and Siberia. To many this fact will doubtless come as more or less of a surprise. For some reason, while Africa, Australia, South America, and Alaska have received a large share of the world's attention during the past fifty years, the vast territory of central and northern Asia has remained unnoticed and unexplored. Only very recently have the exciting events attendant upon the Chinese imbroglio caused the eyes of the civilized world to turn toward the vast domain of Russia, the coming world-power. It is not too much to say, although the statement may be received with considerable incredulity, that it is only within very recent time that Russia herself has paid much attention to her Asiatic possessions.

When in Moscow, outfitting for my first journey to Siberia, in 1898, I made diligent inquiry, among both Russian and foreign residents of the city, as to the necessary articles of baggage on such a journey. My inquiries elicited from most of my auditors only blank stares of astonishment at the thought of any man's taking such a journey as I contemplated. When I went to the office of the Wagons-Lits Company in Moscow to inquire the price of a journey across Siberia to Vladivostok, the French agent told me it was an impossible



MAP INDICATING THE POSITION AND EXTENT OF THE PRINCIPAL GOLD-BEARING DISTRICTS OF SIBERIA.

journey, and watched me narrowly until I left the office, evidently regarding me as some demented person, over whom it would be well to keep a surveillance. Had it not been for the courteous assistance of Mr. Enoch Emery, the American pioneer merchant of east Siberia, I should have fared but poorly in my efforts to obtain some preliminary information about that country. I was also greatly aided by Mr. Henry Hiller, an American who had traded in furs on the Amoor river in 1856, but who had not been through the country for many years.

THE TRANS-SIBERIAN VESTIBULED EXPRESS.

Were it true that Siberia is a country of small resources in a mineral way, or that these resources have in any sense become exhausted by present and former exploitation, I should not take the trouble to attempt bringing the country to the attention of the mining public. It is true that it is difficult to realize that in Asia, "the cradle of mankind," the oldest portion of the earth's surface known to historical research, there should exist beds of gold-bearing sand which have never given up an ounce of their valuable contents, and great reefs of gold-bearing quartz which have never yet been struck by a blow from the miner's pick or shattered by a single pound of giant powder. That such deposits do exist, not only in Siberia but in Mongolia and Manchuria, is a fact attested by all explorers and engineers who have visited the countries in question and have taken the trouble to investigate, even in the most superficial manner, the conditions which exist there.

In the first place, let us consider what is the gold-bearing area of Siberia. Divided into five districts, the auriferous areas in Siberia are as follows:

Ural district, (lying partly in Siberia, and partly in eastern Russia)	60,000	square miles
Yenesei district	280,000	" "
Trans-Baikal district (south)	20,000	" "
Trans-Baikal district (north)	160,000	" "
Amoor district	360,000	" "
Total gold-bearing area	880,000	square miles

As compared with these figures the gold-bearing areas of the United States are seen in the following table:

California	15,000	square miles
Rocky Mountain district, including Nevada and South Dakota	180,000	" "
Appalachian district	10,000	" "
Alaska districts	60,000	" "
Total gold-bearing area	265,000	square miles

In other words, the gold-bearing area of the United States is but little over five times the area of New York State, while that of Siberia is over eighteen times as great.

SIBERIAN TRANSPORT FACILITIES. A WAGON ROAD IN THE ALTAI.

It is doubtful if anyone today would question the statement that the United States is now the seat of operation of the most improved methods for mining and milling the ores of the precious metals. Especially have these methods been perfected to the highest attainable

degree within the last five years, for the production of gold. The aim has been constantly to reduce operating expenses and to increase production. Yet in the year 1899, according to figures furnished by the director of the mint, the coining value of the gold produced within the limits of the territory belonging to the United States was but $71,053,400, or a little over $1 per head of the population. Siberia, during

THE ALTAI MOUNTAINS. DOG CREEK IN THE FOREGROUND.

the same year, with a population of only 22,700,000, as nearly as can be estimated, produced, according to the returns published by the St. Petersburg mint, something under $25,000,000 in gold, or slightly over $1 per head of the population. By what methods the gold constituting this product is obtained in Siberia it is partly the purpose of this article to describe. It is sufficient at this point to note that they are, from the standpoints of capacity, saving of labor, time, and general practicability, diametrically opposed to the methods in use in the United States.

Placer gold, or gold found in stream deposits which overlie the gold-bearing quartz veins, his been and is today the source of the Siberian product. From the time when the Russians first commenced to exploit the Siberian deposits, during the reign of Catherine II.,

there has been but little change or improvement in the mining methods. The prevailing characteristic of the Slav, which may be described rather as conservative activity than as sloth, has caused him to adhere strenuously, one may almost say religiously, to the methods pursued by his ancestors. Placer gold was the first variety found by the early miners. In the history of all mining countries it has been the placer gold which first attracted attention. In California and Australia, however, to take two notable instances, mechanical methods of handling the gravels in which the gold occurs were an almost immediate consequent upon the finding of the deposits. To such a point of excellence

SIBERIAN TRANSPORT APPLIANCES. A TARANTASS ON THE STEPPE.

was the hydraulic method of placer mining brought in California that bodies of gravel carrying but two cents to the cubic yard in gold were profitably handled, and their values extracted.

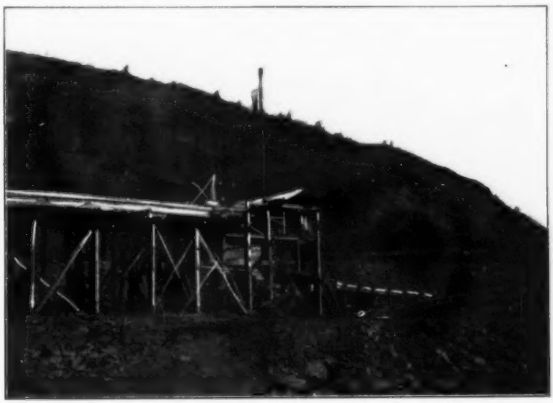
While the Californian and the Australian placer miners rapidly improved their methods of operating and increased their daily product, the Siberian made no changes. It is a most remarkable statement, but one vouched for by observers who have at different times traversed the country, that precisely the same types of gold-washing machines which were in use in Siberia before the discovery of gold in California are in use today in the gold mines of the Lena and Amoor rivers. Such

innovations or improvements as have been made are so few in number and so insignificant in results as to be scarce worthy of mention. A short description of the typical washing-machine in use in Siberia

SIBERIAN MINE LABOR. PEASANT WORKERS IN A PLACER.

at the present day may serve to give an idea of the very primitive methods employed.

A platform set on a staging of rough logs is erected to a height of 25 feet above the ground. The platform is 12 feet in width, and



TYPE OF SIBERIAN GOLD-WASHING MACHINE CALLED THE "AMERIKANKA."

built sufficiently strong to support the weight of several small carts, loaded with gravel, with accompanying men and horses at the same time. An incline with gentle grade leads from the bottom of the gravel

bank which is being worked to the top of the platform. Water sufficient for washing the gravel is either led to the top of the structure from some point higher up the stream, or raised to the required level by means of a centrifugal pump, generally of small capacity. A hopper at the end of the platform opens directly into a horizontally revolving cylindrical screen, through the holes in which the gold and fine material is allowed to pass directly on to sluice tables, while the large

SIBERIAN MINING METHODS. MOVING GRAVEL IN A GOLD MINE.

stones fall from the lower end of the screen into a large bin, whence they are carted away. The actual saving of the gold on sluice tables is done much in the fashion of American placer-mining, although the operations are performed generally in a careless manner which allows most of the finely divided gold to escape. From the time when the gravel is dug from the bank with pick and shovel, hauled up the long incline in carts holding a quarter of a cubic yard, and dumped into the hopper, the operation involves the labor of men and horses entirely, with no mechanical assistance. The rocks and worthless gravel, called "tailings," are also gotten rid of entirely by hand labor in most cases, although at some mines various forms of elevators of small capacity are used.

The result is that the Siberian placer miner expends a large share of his working cost for the hand labor involved in his operation. He never attempts to work gravels where the tenor is less than 33 cents to the cubic yard in gold. Besides this, his daily product is necessarily small. I know of no single machine of the kind described above whose capacity exceeds 500 cubic yards in twenty-four hours. One proprietor with whose operations I am familiar, in order to attain a

product of $800,000 per annum in gold, uses 2,000 men and over 500 horses. The amount of gravel handled during the year is very nearly 1,200,000 cubic yards, and the cost of his operations amounts to three-quarters of the value of the gold produced. From thirty-five to forty machines of the type above described are in use on this property, and besides these there are countless small operations conducted by peasant "tributers." The ground worked in this expensive and laborious manner is in no way different from gravel mines in the United States where the handling and washing of the material is done entirely by means of steam excavators and conveyors.

The work done by the enormous body of men and animals quoted above would require only five American steam-shovels or land-dredges, with suitable machinery for washing the gravel, saving the gold, and disposing of the débris. The services of perhaps sixty men would be necessary, and engine and boiler capacity up to 600 horse power. The entire running and administration expenses would amount to something less than 15 cents per cubic yard of material handled, as against 50 cents by the Siberian method.

DUMPING GRAVEL INTO A SIBERIAN GOLD-WASHING MACHINE.

Did space permit, the citation of statistics from the Siberian operations might be indefinitely prolonged; but the above figures are sufficient to show by what slow and primitive means the annual twenty-five million dollar product of Siberia is obtained. I wish to emphasize especially the fact that this is almost entirely obtained from gold-bearing gravels, or superficial deposits, and that with very few exceptions no attempts have been made to work the quartz reefs lying

underneath. In most localities these have not been even looked for, and when found by accident, they have rarely been tested to ascertain the amount of their auriferous contents. A few quartz mills are in operation in the Ural mountains, which are, with one exception, antiquated in construction and extremely inefficient in operation.

Deep mining, in the American sense of the term, is almost unknown in Siberia. So far as I know, there is not a shaft in any gold-quartz mine in the country which exceeds five hundred feet in depth, nor is there a tunnel a thousand feet long. When this sort of mining activity is compared with that which has recently existed on the South African Rand deposits, or with that of the great Comstock lode, where more than one hundred miles of shafts and tunnels were driven on the vein in a single year, the reasons for such startling contrast appear worthy of some investigation. That gold-bearing veins warranting extensive mining and milling operations exist in Siberia is beyond question. During the course of examinations of Siberian gold deposits

A FLUME IN SIBERIA, SHOWING TIMBER CONSTRUCTION.

extending over a period of fifteen months I have seen lodes in many parts of the country which if worked would pay large returns. An American company, which has established a small gold-mill in the Trans-Baikal district, to the south-west of Irkutsk, reports extremely

A QUARTZ LEDGE AT THE HEAD OF DOG CREEK, ALTAI MOUNTAINS.

favorable results of its operations. Mr. E. D. Levat, a French mining engineer who has explored the country along the Onon river, near the Mongolian frontier, speaks highly of it as a quartz-mining country, at the same time condemning in strong terms the slovenly Siberian mills which have been installed there. In the Achinsk district of Siberia, lying to the west of the Yenesei river and about one hundred miles to the south of the Trans-Siberian railroad, I went with a party of four other Americans to visit the mines of a large Siberian proprietor. This gentleman, much more progressive than his neighbors, has recently installed a Krupp gold-mill of modern pattern at a quartz mine which he has lately discovered. On arriving at the mine after a long "tarantass" drive followed by a horseback journey over one of the foot-hills of the Altai mountains, we looked about with no small degree of curiosity. We followed our host up the gulch to the mine workings, and entering one of the prospect tunnels, proceeded to examine the ore.

The wall-rock of the vein appeared to be full of little crystals of iron sulphide, and on closer inspection particles of gold were visible. The finding of free gold in the rock, away from the quartz of the vein, was rather extraordinary, and it in some measure prepared us for the

appearance of the quartz in the face of the drift. Here, by candle-light, on the face of quartz eight feet in width, appeared wire-like strings and masses of native gold, extending in lines more or less parallel to the walls from top to bottom of the drift, which was about six feet high. Such an unprecedented display warranted the opinion that here was the prize "specimen mine" of the world, or that Siberians were past masters in the art of "salting." More was to come, however. In no less than six openings on this vein, all following it from fifty to two hundred feet into the mountain-side, we were shown these marvellous exhibitions of free gold. Blasts of powder were put in wherever we

OLD TAILINGS BEDS IN THE ALTAI MOUNTAINS.
A promising opportunity for reworking by modern methods

directed. Specimens were taken from the fresh face, beaten up in mortars and panned. In every case gold was found, often at the rate of hundreds of dollars to the ton. Salting appeared out of the question, and a subsequent examination of the vein along a course of seven hundred feet showed the free gold already found in the tunnels. By an exhibition of his government record books kept by order of the mining department to accompany the consignments of gold turned in to the agents of the St. Petersburg mint, the owner proved to us that he had in four-months time taken over $50,000 from this vein, crushing only 18 tons of ore a day.

That the deposit described above is not of an exceptional character in Siberia could be proven by the citation of numerous examples. It is sufficient to show, however, that where sensible and business-like

SIBERIAN MINING METHODS. WORKING A SHALLOW PLACER.

mining operations have been undertaken they have met with success. By means of the railroad, central Siberia is now much easier of access than are portions of the United States, and the rates of transportation for both passengers and merchandise are extraordinarily low. Large cities, provided with first-class hotels and possessing all the luxuries of civilized life, are numerous. The climate is remarkably healthful and enjoyable, the winters, generally thought of as unbearable by persons ignorant of the country, being considered by all those who have experienced them the most enjoyable time of the year. Gold mines in the mountains of Colorado are operated the year round under conditions of climate far more inclement.

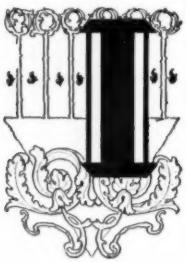
Mr. G. F. Becker, an American statistician and mining engineer of the most eminent authority, places the future production of the Witwatersrand gold mines of South Africa at $100,000,000 a year for the next thirty years—dependent, of course, upon the restoration of peaceful political conditions. I regard it as not an unsafe prediction to estimate the Siberian annual gold output at $200,000,000, for a period of at least thirty years, providing American machinery and gold-mining methods are installed throughout the territory now occupied by the Russian and Siberian operators.

THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

III.—THE SCIENTIFIC MACHINE RATE AND THE SUPPLEMENTARY RATE.

Mr. Church's first article, which appeared in our July issue, dealt with the vital necessity of accurate cost keeping. His second paper analysed the chief accepted methods of apportioning general expense to individual jobs and pointed out their deficiencies. In this article he develops a comprehensive and accurate system. His next paper will take up the classification and dissection of shop charges.—THE EDITORS.



IN the last article, an outline of a new basis of determining the incidence of shop establishment charges was given. Before passing to consideration of the preliminary measures necessary to its introduction, the effect and results of the method will be detailed. The apparent similarity of the system to the old device of the machine rate has been alluded to; the points of difference will now be brought into prominence. It will be remembered that the principle on which the proposed method was stated to be based, was that of dividing each shop up into its constituent "production centres" and giving full play to the natural differences between these as far as practicable, instead (as on the averaging plan) of throwing them into one common receptacle or lump sum of shop charges. It was also pointed out that this of itself would be subject to all the defects of the old machine-rate method, inasmuch as the problem of idle hours is still unsolved. There is also the problem of those actually general charges, which cannot by any reasonable allocation be connected with particular production centres.

Leaving these latter out of account for the moment, it will be seen that, admitting all machines or production centres to be running full time, it would be possible so to adjust the rents or machine rates payable for the use of these centres during one hour, that at the end of any period, say a month, the whole of the shop charges would find themselves attached to particular jobs, according to the time taken by each job.

TOTAL OF SHOP CHARGES FOR 1 MONTH—$200.			
MACHINE.	WORKING HOURS PER MONTH.	RATE PER HOUR ON NEW PLAN.	MONTHLY EARNINGS ON NEW PLAN.
A	200	40 Cents	$80.00
B	200	30 Cents	60.00
C	200	20 Cents	40.00
D	200	10 Cents	20.00

Total hours worked by all four machines, 800. Hourly burden $= \frac{200}{800} = 25$ cents.

Total distributed by hourly-burden plan, 800 hrs. @ 25 cts. = $200.00.

Total distributed by machine rates on new plan, $80 + 60 + 40 + 20 = $200.00.

In the above schedule, there has been given the case of a certain shop, in which the monthly total of shop charges was $200. The time made by the constituent production centres, viz., machines A, B, C, and D, was 200 hours each, or 800 in all. Now on the hourly-burden plan this would give an average hourly rate of 25 cents for all jobs, on whichever machines they happened to have been done.

But it is assumed that the application of the new method and thereby the separation instead of lumping together of the incidence of charges has resulted in the rates of machine A being fixed at 40 cents, of B at 30 cents, of C at 20 cents, and of D at 10 cents. Again assuming the full number of hours to be worked, it is easy to see that we get considerable differences in the resulting incidence of shop charges on the two plans. The charge, for instance, on a job which occupied 5 hours of machine D and 1 hour of machine A would be:

On hourly-burden plan—6 hours at 25 cents = $1.50.

On new plan—5 hours on D at 10 cents = 50 cents; 1 hour on A at 40 cents = 40 cents; total, 50 + 40 = 90 cents.

We may now consider what would be the incidence under the percentage-of-wages method of distribution. Let it be assumed that the wages of operators on A and B machines are 20 cents per hour, and of operators on C and D machine 15 cents per hour. Reckoning, as before, 200 hours per month for each machine, we find:—

Total wages for one month, $140, and as shop charges are $200 this gives an average of 142 per cent. on wages-value for all work done, by whichever operator or whichever machine concerned. Hence we get the charges incident on the job we have been considering:—

5 hours of operator on D at 15 cents = 75 cents, on which charges at 142.9 per cent. = $1.07.

1 hour of operator on A at 20 = 20 cents, on which charges at 142.9 per cent. = 28 cents.

Total charges for job $1.07 + $0.28 = $1.35.

We have now worked out this job on three methods, and find different results in each case, viz:—

On hourly-burden plan	$1.50
On new plan	0.90
On percentage method	1.35

Which of these is most correct?

The nearness of results obtained by the hourly-burden and the percentage plan makes these two methods apparently support each other. But this in reality is due to the fact that we have assumed a very slight difference (only 5 cents) between the highest and lowest wages rate. This contributes to make the real basis of distribution as nearly uniform in this case as the hourly burden. By this is meant that the value of an hour having been made nearly uniform, it is much the same in effect whether we distribute on hours or value of hours. It will be recognised that in proportion as wages rates differ, so will the discrepancy between the distribution on the hour and on the hour-value increase. Between these two methods there is already a difference of 15 cents, which, as just shewn, might easily have been much greater if the difference in the assumed wages rates had been made larger. To begin with then, let us ask which of these two may be considered the more accurate. The discrepancy being clearly due to the introduction of the wages factor as a measure of incidence, we need only enquire whether this lowering of the charge under the percentage system is a nearer approach to truth than the other.

If we assume that the $200 of shop charge is wholly made up of standing expenses, rent, interest, depreciation, and such-like, we must decide in favour of the nearer correctness of the hourly-burden plan in principle. It at least is based on an invariable basis, which, though not representing the real state of affairs, is constant in its error. But we can easily see that the other result has more of the element of chance in it. It will vary according to just what man has happened to be on the particular job. And if the worker did not receive any wages at all, the charges would be reduced to nil.

This objection still holds, though in the particular job cited the percentage plan has given us a figure nearer to that provided by the new plan than the hourly-burden figure, which we have notwithstanding argued to be the more correct in principle. This paradox is explained by the consideration that had by any chance the wages not

been scaled proportionately to the machine rates, the discrepancy would be far greater between the new and the percentage, than between the new and the hourly plan. In the case of a low-waged operator working a highly rated machine, and *vice versa*, the discrepancies would plainly pass from positive to negative on the percentage plan, whilst on the other two plans they would not vary. The fault of the percentage plan is, then, that it fluctuates according to a factor which cannot be considered as really representing a true and corresponding variation in the incidence of shop charges. The fault of the hourly-burden plan is that it does not vary at all. As between these two evils, our preference must be for that one which produces the most constant error.

It has been assumed in the above argument that the new plan does produce a result not merely relatively more correct than either of the two others, but that it gives a normal result closely connected with actual conditions of work. Remembering that we are still discussing the case of a shop in which all machines are making full time, it is difficult to see how we are to avoid coming to this conclusion. It is evident that the standing charges, at any rate, comprising such items as interest and depreciation on particular machines, the proportion of rent, taxes insurance, heating, etc. (which may be considered as reduced to a certain uniform charge for each square yard of floor space, and thus debited according to the working space occupied by any machine) and all charges allied to these, can be as properly assigned to particular production centres as in the case of rents in large buildings which are let out in subdivided areas to tenants.

No sophistry is needed to assume that these charges are in the nature of such rents, for it might easily happen that in a certain building a number of separate little shops were established, each containing one machine, all making some particular part or working on some particular operation of the same class of goods, but each shop occupied, not by a wage earner, but by an independent mechanic, who rented his space, power, and machinery, and sold the finished product to the lessor. Now, in such case, what would be the shop charges of these mechanics? Clearly they would comprise as their chief if not their only item, just the rent paid. And this rent would be made up of: (1) Interest. (2) Depreciation. (3) Insurance. (4) Profit on the capital involved in the building, machine, and power-transmitting and generating plant. There would also most probably be a separate charge for power according to the quantity consumed.

Exclude the item of profit, which is not included in the case of a

shop charge, and we find that we have approached most closely to the new plan of reducing any shop into its constituent production centres. No one would pretend that there was any insuperable difficulty involved in fixing a just rent for little shops let out on this plan. Nor can there be any more difficulty in fixing the proper charges for each production centre in a large shop. The little shops are, in fact, a large shop when we take away the partitions which divide them. The presence of these partitions certainly seems to make the problem more definite and concrete, but this is a mere illusion. There is a new point of view involved, which, once grasped, enables us to see separately things which otherwise have a look of conglomeration.

This illustration of the little independent shops is also useful in helping to discuss the question of idle hours. In each of these little shops, whether idle or busy, the rent is going on all the time. Only the charge for power might conceivably be stopped whilst the shop was shut. Now if the mechanic in one of these shops is only working half his time, it is pretty clear that he must double his rate of distribution on such work as he does, if he is to distribute his month's rent over his month's work. But instead of doubling his rate, he might continue to charge at the normal rate, and then at the month end find how much he was yet in arrear, and distribute this undistributed amount only as a *supplementary rate.* In this way he would benefit in two ways. First, his normal rate being constant, he can compare costs of jobs worked on at different periods, and secondly the amount of the supplementary rate, (its ratio to the normal rate,) will serve as a very accurate barometer of the conditions under which he has been working at any period. If the normal rate has been so fixed, for instance, that when fully employed the supplementary rate was *nil* per cent. of the normal, then if he observes it steadily rising 5 per cent., 10 per cent., 15 per cent., etc., he may be fairly sure that things are not going well with him. Of course, in the case of a little shop, this would be perfectly clear to him without the aid of the rates to tell him so; but if we, now, throw down all the partitions and make the hundred separate little shops into one large general shop, this information may be very important indeed to those in authority.

The meaning of the term supplementary rate will now be understood. It is this which is the invaluable complement to the machine rate and which makes the great distinction between the new method and the old machine-rate method. *The supplementary rate is the undistributed balance of shop charges due to idleness of productive centres.*

In the illustration just given of the little shops, it will be seen that the undistributed balance due to slackness of one machine is thrown onto whatever work is done at all on that machine at some time or other. This is, of course, necessary in the case of independent little shops, but when the partitions are down, and we consider the case of a *bon fide* large shop with a number of production centres, this is no longer always possible, or even desirable from some points of view.

The idleness of a machine may or may not be considered as the fault of that machine. If, for instance, a machine was found to be idle nineteen-twentieths of its time, this might be due to one of two causes. Either the process was rare but essential, or the machine itself was largely superfluous. In the first case it would be eminently fair that the charge should be made very high when it was put in use, since the shop charges due to its presence and up-keep are indubitably incurred for the sake of this occasional use. In the second case it might be rather as a matter of accommodation that the machine was retained at all, in which case the shop as a whole should bear the burden, and not the unlucky piece of work that should happen to be put on such machine at any time.

Here we have one of those matters of principle which are incapable of a general solution. The procedure proper would vary according to actual circumstances. Nevertheless, the general practice will probably be that idle machines shall get rid of the burden undistributed during their idle periods, not by charging it specially in their working periods, but by transferring it to the general shop-charges account.

If we adopt this view of the usual destination of idle hour's burden, then we introduce at once a striking difference between the case of the little independent shops and the same machines considered as production centres of one large shop. In the former, idle time accumulates against its own machine; in the latter, all undistributed charges fall, not into the supplementary rate of particular machines, but into a general supplementary rate for the whole shop. It is also into this supplementary rate that the really general expenses of the shop fall.

The full outline of the new plan may now be seen. First, we consider each machine as an independent production centre, allocating to such centres all the expenses and charges which can, on reasonable analysis, be considered as chargeable as a composite rent or machine rate for all the factors of production therein concerned. Second, we charge to a monthly shop-charges account all charges whatever incurred by that shop, including all the items specifically represented in fractional detail by the machine rates, and also including, of course,

such general items as cannot be represented in the machine rates, of which the most obvious item is the supervision of a head, or foreman.

Then, as each machine is occupied on jobs, the latter are debited with so much per hour as machine rate, and at the end of the month the total amount so earned by the machines, *is deducted from the total shop expenses,* leaving a balance which is distributed over the same jobs as a *supplementary rate.* The ratio of the supplementary rate to the amount distributed by the machine rates forms a varying barometer, whose fluctuation is an index to the current efficiency of the shop.

It will, of course, be obvious, from what has already been said, that when the machines are all running full time the supplementary rate will consist of the general charges alone, such as the foreman's wages, which have not any individual connection with particular machines. This will be the condition of maximum efficiency in the shop. In proportion as all machines are not kept full of work all the time, this ratio of the supplementary rate to the amount distributed by the machine rates will begin to rise. The same effect will occur if any general kind of expenditure is increased.

While we have now seen the principle of the supplementary rate in detail, there yet remains the question on what basis the additional distribution shall take place. It may, for instance, be made into an ordinary hourly burden, or, which is simpler, may be reduced to a percentage of increase on the amount already distributed by the machine rate. In the case of the shop whose charges amount to $200, cited above, we may suppose:—

Machine A worked 120 hours @ 40 cents = $48.00 for month.
Machine B worked 134 hours @ 30 cents = 40.20 for month.
Machine C worked 169 hours @ 20 cents = 33.80 for month.
Machine D worked 200 hours @ 10 cents = 20.00 for month.
Total 623 hours. Total burden distributed, $142.

Now deducting the total burden distributed through these machine rates, viz., $142, from the full month's total of shop charges, viz., $200, this leaves $58 as a residual or undistributed amount. This forms the amount to be made the subject of the supplementary rate, but this itself may take two forms. It may be treated as an hourly burden, thus:—$58 spread over 623 hours worked = $9^1/_3$ cents per hour, which amount would have to be added to the amount already allocated by means of the machine rate; or, it might be that the residual amount is reduced to a percentage of the amount already distributed, thus:—total burden distributed by machine rates, $142, residual amount, $58; supplementary rate = per cent. of increase on

machine rate amount, = 40.9 per cent. On this latter plan the calculation of the correct incidence of shop charges is reduced to a very simple matter. First we get a certain amount charged against the job by the medium of the machine rate. This represents strictly the normal charge for that machine when under full work. Then at the month end we find the actual ratio of undistributed to distributed charges, and increase the debit against individual jobs accordingly. Thus:—

5 hours of machine B at 30 cents = $1.50
Supplementary rate at 40.9 per cent. = $0.61

Total charges..... = $2.11

This represents: (1) A proportion of the really general charges of the shop, and (2) An averaged distribution of the idle hours of any or all the machines in the shop.

As by the new machine-rate plan we have only subtracted from the total charges just those charges which *can* be connected with different production centres, it follows that, as regards the remainder, we are again face-to-face with the problem of finding a suitable basis on which to make the distribution of incidence.

The discussion of which is the better and more just way of distributing this residual amount, or supplementary rate, is worthy of some attention. Theoretically, as regards the idle hours, we are averaging these over the work actually done, and this is on the basis of their being considered as the fault of the shop as a whole, and not of any particular machine; but this may be as well attained by distributing the supplementary amount directly as an hourly burden, or a *pro rata* increase of amounts already charged through the machine rates.

The general, or, as we might more conveniently term them, the floating shop charges, plus the unallocated charges due to idle machines, are obviously not connected in any definite way with the work. They must be averaged on one basis or another, and this basis should be as constant, that is, subject to as few variations, as possible. This definition is better fulfilled by the hour than the hour-value. It is to be preferred, therefore, that the supplementary rate should be an hourly-burden rate. This, though not quite as simple in routine as the percentage form of supplementary rate just described, is the more accurate, because the incidence of the unallocated charges cannot be considered as varying with the value of different machines, but rather as pressing equally on all work done in the shop hour by hour, irrespective of whatever machine it may be done on. Nevertheless, the percentage supplementary rate is not without its arguments, since

it means virtually a *pro rata* increase of machine rates in slack times, and this is very much like what might be conceived to happen in the case of the separate little shops which have been used as an illustration, supposing that from one cause or another it became necessary for the landlord or owner to get the same return out of a smaller number of little shops. He would raise the rents. But this is exactly equivalent to a distribution of the supplementary rate as a percentage on the amounts already distributed by machine rates.

This is in any case quite a different matter from a percentage distribution of shop charges on wages, and is not vitiated by the arguments already directed against that method. At this stage the matter may be left an open one, with preference in favour of the hourly-burden method of distributing the supplementary rate.

A summary of the complete scheme of machine rates and supplementary rates is now possible.

The principle followed is to connect expenditure with production centres, (which for the most part mean machines) wherever this is possible and as far as it is possible. These charges are debited to jobs by machine rents or rates so carefully arranged as to include all of them. All these items of expenditure, and others which we term floating or general items (which do not enter into the composition of the machine rates at all) are collected into a monthly shop-charges account. This account is relieved by the total of charges which have been debited to jobs during the month, by means of machine rates, leaving in the account a residual sum, which has yet to be got rid of and allocated to jobs. The supplementary rate affects this, either by reducing the residual amount to an hourly burden, distributed over the jobs in the usual way, or, more simply but somewhat less accurately, by finding the proportion or ratio of the residual sum to the amount already distributed by machine rates, and then increasing the amounts already allocated to each job by so much per cent.

It will be obvious that by this means *all* the charges will be distributed, leaving nothing in the charges account, and that if all the machines have made full time in the month, the supplementary rate will only represent the floating shop charges. In proportion as machines are idle the supplementary rate will rise, because only working hours are credited to the shop account as per the total of the machine rates found at the end of the month.

Thus we secure that each job gets its own expenses only attached to it, plus an average of floating charge and of what surplus may be due to slack times or inefficiency in the shop.

THE MARINE WATER-TUBE BOILER.

By John Platt.

THE recent trials of two British cruisers, the one fitted with Scotch and the other with water-tube boilers of the Belleville type, has again brought up the much discussed question as to which is the better for fast ships of the battle-ship and cruiser classes. The activity of the argument has been much augmented by the stand taken by many technical papers and the daily press, in assuming from the results obtained and from the report of the British water-tube boiler commission that the Belleville boiler was wholly bad, and that vessels fitted with it were necessarily of no account.

It is not my intention to discuss the merits and demerits of Scotch and water-tube boilers in this article. The fact will be taken for granted that for large fast naval vessels, a large proportion of the boiler installation must of necessity be of the water-tube type. Rear Admiral George W. Melville, the well known and brilliant chief of the bureau of steam engineering of the United States Navy, has given detailed reasons why he has now been forced to use water-tube boilers. As is well known, his bureau has specified water-tube boilers in all the ships authorised by the last two congresses.

The subject will be discussed from the stand-point of one who has had experience with the express type of water-tube boilers, the question being raised as to whether full advantage has been taken of the very excellent results obtained from their use in torpedo boats and destroyers, particularly considering the fact that in such vessels boilers are forced to a much greater extent than in any others.

It was only as far back as 1887 that the first torpedo boat was fitted with water-tube boilers. Since that date many different forms of these boilers, all built of high-class materials and with modern boiler-making

details, have been used in big ships. At the present time, even with this experience, we seem to be very little nearer the knowledge as to what is the best form of water-tube boiler to use where from 15,000 to 30,000 horse power is required, as is the case in large battle-ships and cruisers and in ocean liners. In considering the question it seems to have been very generally taken for granted that the proper form of boiler for this purpose must have large straight tubes—that is, tubes of from 3 inches to 4 inches in diameter—this notwithstanding the fact that there were so many practical reasons available to show why developments along other lines would tend to give excellent results.

The water-tube boiler was never very successfully used on board ship until torpedo-boat practice made the employment of the type absolutely necessary to enable the builders to obtain the speeds found possible in a boat of a given displacement. The locomotive type of boiler gave good service and was used with air pressures from 8 inches to 10 inches, this high pressure latterly being necessary to give the large amount of power required. Such extreme forcing with the rigid form of construction led to leaky boilers and many disasters. Again, the weight of the boiler was great for the horse power given out. The problem that the boiler builders had before them was to design a boiler that could be forced, that would be economical, and of the lightest weight possible. This, as is well-known, was successfully done and the results obtained from the use of these boilers led to a great increase of speed in the boats.

The boilers worked out for this purpose were of two general types —the one with small straight tubes, and the other with small bent tubes, the tubes in each case being of outside diameter from 1 inch to 1⅜ inch. They are generally spoken of as "express" boilers. Innumerable forms of these two general types have been designed and built during the last ten or twelve years. Many of these have been of defective general design, and many with such bad boiler-making details that at the present time the whole class suffers from the unsatisfactory results obtained from the large number of poor ones.

It will be instructive to see to what extent the express boiler has been used in torpedo-boat and destroyer work, and the size and number of the units employed, so that we can the better determine its suitability for use in the larger high-power ships. The first torpedo boats in which they were used required only from 1,000 to 1,500 horse power and two or three comparatively small boilers were sufficient. The latest United States destroyers require 8,000 to 8,500 horse power, and as only four boilers can well be used for this purpose, the size of

the units must of necessity be large. Some of these particular boats have already run their trial trips, obtaining the amount of horse power required. On their full-speed trials, from 25 to 28 horse power per square foot of grate was developed. In a large number of similar boats in the British Navy the horse power per square foot of grate runs up to 30 and even 31. Notwithstanding this very extreme forcing, the horse power was obtained in all cases under 2.5 pounds of coal per horse power per hour, the consumption in some cases being as low as 2.2 pounds. The objections that might be looked for from such extreme forcing are low economy, wet steam, priming, and difficulty in keeping clean fires. The British Admiralty torpedo-boat destroyer tests show clearly that well designed boilers of the small bent-tube type are economical, and steam would not allow of this economy being obtained. With the very quick-running engines used on destroyers, priming would inevitably lead to serious disaster. Such disasters are few. On destroyers, the good quality of the coal used and high air pressure necessary to burn from 60 to 70 pounds of coal per square foot of grate per hour, have together done much to enable the fires to be kept clean, so much so that there has been no difficulty at all, where good coal has been employed, in obtaining easily the full horse power at the end of the three-hours official trial.

The first large ship in which the modern boiler was fitted was H. M. gunboat Speedy, built in 1892. The Speedy has a battery of eight boilers which developed on trial 4,700 horse power. As each boiler had only 23.5 square feet of grate and 1,840 square feet of heating surface, it will be seen that the units were small. Small boilers have been found in practice to be more difficult to handle than large ones; but even with a battery of eight such small boilers, in ordinary service, the navy stokers have easily been able to get 5,000 horse power out of the boilers. The Speedy's boilers had 1⅛-inch and 1¼-inch tubes respectively of 12 and 14 B. W. G., and the boilers were made no heavier than torpedo-boat practice called for. The tubes in these boilers lasted for over seven years without renewals and the boilers gave no trouble at all. A similar installation was fitted a little later in the ironclad Aegir of the Imperial German Navy, and the boilers were later fitted to the Hagen and Beowulf, sister ships to the Aegir. These have all given excellent results, and the express type of boiler is being more largely used in the German navy than any other form of water-tube boiler. In the later ships the Germans have used part single-ended cylindrical and part express water-tube boilers. The advantages of this system will be referred to later on. Twelve battle-ships and

cruisers of from 11,000 to 13,000 tons displacement and 13,000 to 16,000 horse power and all the second-class cruisers are fitted throughout with small bent-tube water-tube boilers. Both the Danish and Dutch navies have a number of vessels fitted with express boilers.

In spite of the fact that in 1894, when Sir A. J. Durston determined to use water-tube boilers, he had the experience of the Speedy and the boilers in the torpedo boats and destroyers to look to, both he and the water-tube boiler committee did not seem to be able to get the idea out of their minds that for big ships only boilers with large straight tubes were suitable. Thinking as they did at that time, the Belleville boiler was the natural one to take up. The express type was used only in third-class cruisers, the greatest amount of horse power in any such boat being 7,000 horse power. These boats were not suited to the proper development of this boiler, as from their general form a comparatively large number of small units were necessary.

In the United States Navy the bureau of steam engineering have to a great extent taken the same stand, and now specify water-tube boilers with straight tubes 2 inches or more in diameter. Before this ruling was made, two battle-ships, the Ohio and the Missouri, each having 16,000 horse power, were approved; also a monitor with 4,000 horse power. These two battle-ships will enable a comparison to be made with the large-tube boiler, as a sister ship, the Maine, is being fitted with Niclausse boilers.

The Ohio, building at the Union Iron Works, San Francisco, has a battery of twelve Thornycroft boilers. A little more floor space is taken up by the express boiler, but the boiler-room weights of the Ohio are much less than those of the Maine. The use of only twelve boilers instead of twenty-four means that there are only half the number of water levels to be looked after, and that only twelve sets of boiler fittings, stop valves, etc., have to be supplied and taken care of. As only about 16 horse power per square foot of grate area has to be developed in the express boilers, the stack temperature will be from 400° to 500° F., rendering the use of an economiser unnecessary. This advantage is an important one, possessed in the greatest degree by the boiler with small bent tubes in which the gases are made to take the best possible course by means of a wall of tubes. In the large straight-tube boilers artificial means of baffling are often made use of, and even with these, in many cases, under the same conditions of steaming, the flue temperatures are several hundred degrees higher. This has led to the use of economisers, which should be considered as part of the boiler when taking account of heating surface.

To recapitulate, the experience gained from the study and use of the express boilers leads one to claim the following advantages over the boilers of the large straight-tube type:

Saving in weight; smaller number of units possible, and hence fewer steam fittings to take care of; low stack temperature, and quicker steaming. In the types having small bent tubes—owing to the flexibility of the tubes—freedom from straining at the tube ends; positive and vigorous circulation, and hence no possibility of steam pocketing.

These advantages have been fully made use of only by the Germans. They are now working on the principle that for fast cruisers and battle-ships the ideal system is made up of an installation consisting of two-thirds water-tube boilers of the small bent-tube type and one-third cylindrical or Scotch boilers. It is claimed by them that the lighter weight, ability to stand extreme forcing should it be necessary, and quick-steaming power of the express boilers of the class above named, make it for tactical reasons the best possible for this class of ship. The cylindrical boiler, with more reserve of water, and better adaptability for use with impure water, is used for slow cruising and in port for evaporator and electric-light work. The following extract from a statement made by a leading German naval engineer connected with one of their large shipyards, will bear out the above statements:—

"You make mention that in England a great current of opinion is going in favour of straight tubes, but in our marine one is getting farther and farther therefrom and drawing towards the bent small tubes, owing to the advantages of the same—especially life, good circulation, and safety in working, which abundantly outweighs the disadvantages of the inner cleaning of the tubes."

That the above statement is correct can be readily seen from the fact that of the battleships and cruisers of the German Navy, 20 per cent. of the boilers are cylindrical, 25.5 per cent. large-tube water-tube boilers, and 54.5 per cent. small bent-tube water-tube boilers.

In speaking of the recent large ships of his navy he says:—

"In Nos. 1 and 2, two-thirds of the boiler space is fitted with cylindrical boilers and one-third water-tube boilers; in Nos. 3 to 10, one-half cylindrical and one-half water-tube; in Nos. 11 and 12, one-third cylindrical and two-thirds water-tube boilers. With the results of the first ships one is extremely satisfied, and it is hereby specially to be noted that the cylindrical boilers, since the addition of the water-tube boilers, have had definitely greater care taken of them. In the cylindrical boiler, at the most, 110 to 120 kilogrammes of coal per square

metre of grate surface per hour was burnt, whereas in the water-tube boiler proportionately higher results have been obtained, viz: 190 to 210 kilogrammes of coal per square metre of grate per hour, and, in fact, with very good economy in the latter boiler."

"The small-tube water-tube boiler is thus having preference over every other type, especially with regard to its adaptibility in war times. The report is unanimous from all sides of the front, that is from officers and personnel who have had to do with the boiler, that these boilers are best suited to the purpose. With reference to harbour purposes, and also the use on long sea voyages at moderate speed, a part of the boiler installation will still consist of the old large water-room (cylindrical) boilers, which can very easily work with not quite clean feed water."

Speaking of the large-tube water-tube boilers in use in the Imperial German Navy he says:—

"These boilers require, in order to have the necessary working safety, a proportionately high weight in order to receive the safety of working of the small-tube boilers. Dirty water and scale have a very injurious influence on tubes placed near the fire and also on the higher rows of tubes. They easily warp through deposit of first a little and then more and more scale, and the circulation on the inner side of the tube will be hereby influenced, and through the weakening of the tube as soon as an over-heating takes place it is greatly weakened so that even with the best seamless material at first a tear and then an explosion takes place, which endangers the life of the crew in charge. Similar results can take place in the small-tube water-tube boiler even by the use of bad or unfiltered water."

"A further objection to the large-tube boilers is on account of the careful inspection that is required, especially of the inner row of tubes. In case of war one would not be able to carry out a complete inspection, as far too much time would be lost by the taking adrift and refitting of these tubes with the thousands of doors. Against this, in the case of the small-tube boiler, the inspection and cleaning take no more time than in the case of the old cylindrical boiler; in both cases the inside is immediately accessible after taking away the manhole doors. All tube connections can be easily inspected, as the upper and lower barrels are roomy enough for both inspection and cleaning."

The foregoing has been written in the hope that it will cause more attention to be paid to the possibilities of the express type of boiler for use in big ships, and particularly when used in combination with cylindrical boilers.

EDITORIAL COMMENT

Possibly the greatest engineering interest of the recent weeks has been the strike in the American steel industry—a strike which as we go to press is no longer great. Its failure already discounted in the street, its progress relegated to subordinate position in the press dispatches, the pyrotechnic display promised by Mr. Shaffer has sizzled in the fuse and sputtered and smouldered, instead of bursting into a majesty of flame as predicted.

The interest was intense because of the fundamental importance of the steel industry, stagnation there being more universally paralysing even than general stoppage in the engineering trades—which, indeed, would inevitably follow; but it was yet more intense because of the international scope of the question. A cartoonist represented the United States Steel Corporation and the Amalgamated Association as two dogs, fighting for the bone of "Profits," while John Bull, leaning over the fence with gleeful interest, cries "Seize him!" It is a very short-sighted view which does not comprehend that trade-union success in this instance would have been scarcely less disastrous to Britain than to America. Economically, the countries are now so closely bound together that each furnishes precedents for the other. The great engineers' strike of 1897-1898 predetermined the result of the American machinists' strike of 1900-1901. If trade-unionism had imposed its conditions on the American steel trade in this struggle, the bonds would soon have been fastened on Britain also.

* * *

The whole contention has been like to that over which Britain struggled four years ago—the reasonable delimitation of the rights and powers of the union. The steel managers were entirely willing to agree with the unions' officers touching the unionised mills: they proposed to continue conditions exactly as they had been, curtailing in no jot or tittle the power or influence of the Amalgamated Association. The other mills were to remain open, with no discrimination by either side against either organised or unorganised labour. The union demanded that the Steel Corporation agree with them as to *all* its mills, non-union as well as union, effectually throwing under union regulations the enormous body of workmen who for reasons presumably acceptable to themselves had preferred to remain outside of any organisation. The issue was joined, of course, only over the tin-plate, sheet, and hoop mills, but whatever was done there was an inevitable precedent for the entire range of the industry. There was no question of wages, hours, or conditions of working—it was purely an issue or recognising and submitting to trades-union domination. The Steel Corporation met it promptly and positively and the end is history. If the Amalgamated Association has suffered, it is through the folly of its own leaders in taking an untenable position and then forcing a fight.

* * *

It is deplorable that the men must have reason and experience beaten into them, but the world has gained most of its knowledge that way,—and cheap enough at the price, if only the knowledge is held and used. The trouble is not that they do not think, but that they think with a twist, and the twist can only be corrected by surgery—costly and painful. Unionism is to them an absolute, deserving of anything it may demand, justifying any act of its devotee, nullifying any obligation elsewhere. Mr. Shaffer in seeking to make the strike general by calling out the satis-

fied workers in other departments of steel manufacture says:

"You will be told that you have signed contracts, but you never agreed to surrender those contracts to the United States Steel Corporation. Its officers think you were sold to them just as the mills, with contracts and all. Remember, before you agreed to any contract you took an obligation to the Amalgamated Association. It now calls you to help in this hour of need."

In this instance, however, the men in very large proportion showed greater economic wisdom and a higher sense of business morality than their leaders, and regarded their working contracts rather than the autocratic demands of the union officers. If any justification were needed for the Steel Corporation's attitude in declining to extend voluntarily the power of the Amalgamated Association, it is this utter irresponsibility displayed by the Association's officers. That, and not any opposition by the employers, will do more to discredit the cause of unionism than long and painstaking effort can atone for.

* * *

Touching the matter of responsibility of the trades-union, the decision recently rendered by the House of Lords in the Taff Vale Railway case has the utmost significance, especially as by established usage English precedent is weighty in American law. Briefly, the railway sued the Amalgamated Society of Railway Servants for "besetting" (American, picketing), employees willing to work during a strike. The Society offered the defense that a trade union could not be sued. Mr. Justice Farwell, sitting in the case, decided for the railway. The Court of Appeals reversed, but the House of Lords reaffirmed the original decision. The Lord Chancellor stated it thus: "If the Legislature has created a thing which can own property, which can employ servants, which can inflict injury, it must be taken to have impliedly given power to make it sueable in a court of law for injuries done by its authority and procurement." The railway company is granted a perpetual injunction against the besetting annoyance and given permission to proceed against the society for monetary damages for its injuries sustained.

It has been held good law that "where there is a wrong there must be a remedy." Now that it is clearly ruled that the remedy in the case of union tyranny is against the union itself, a long advance is made in establishing the means of discipline by which organised labour may be educated from the wrong-headed things it so often attempts, to the great good it may do. Leaders will be much less ready to suggest, or followers to commit, acts injurious to the property or the rights of others when they are certain they must assume the accountabilities of a corporation as well as enjoy its privileges. And the ultimate result will be highly advantageous to the cause of organisation among workingmen. The rod may belong only to very early periods of education, but that seems to be the period through which trade-unionism is now passing.

* * *

One of the most disappointing things frequently observed in connection with great exhibitions is the unsatisfactory management of the exhibits themselves by their exhibitors. It is surprising that this feature has been given so little attention by manufacturers and others who expend large sums in providing and installing exhibits, and who then place them in the hands of individuals who either neglect them, or worse, actually repel the interested attention of visitors. It is the exception rather than the rule for visitors to be welcomed to examine the various devices and machines shown by many first-class manufacturers, and indeed the general rule seems to be to regard with suspicion any one who desires to look at things.

If the machines or exhibits are not to be seen and understood by all there can be no good reason for occupying space with them at all, while if the makers really desire to get the full benefit of the space and the cost, they should at least understand that polite, courteous, energetic, and really competent attendants, supplemented with intelligible printed matter, form the final element in the relative success or failure of the attempt.

REVIEW OF THE BRITISH PRESS

Comparative Boiler Trials in the Navy.

It is curious to observe the peculiar inverse process which has been adopted by the Admiralty in treating with the fundamental question of boilers for the navy. First the decision is made that cylindrical, or "tank" boilers are no longer the best type for naval use; followed by the adoption of the Belleville water-tube boiler for several of the finest battle ships under construction at that time, together with the payment of large sums for the use of patent rights. Then, after repeated mishaps with the Belleville boiler, and a general expression of distrust in the policy of putting this boiler in additional vessels, comes the appointment of a commission to report on the relative availability of the Scotch or the Belleville type, together with the desirability of trying some other forms of water-tube boilers. Then, upon the report of the commission deciding positively that the Scotch boiler was no longer suitable, and that water-tube boilers should be used, together with the sweeping condemnation of the Belleville boiler, comes the comparative trials between the boilers of the Minerva and the Hyacinth, for the purpose of finding out which of the two condemned types is really the better. So we have the cruise to Gibraltar and back, in order to enable the commission to find out something about the two types which they have already decided to be altogether unfit. It is a situation altogether worthy of Lewis Carroll, and should have taken place in that land beyond the looking glass, where everything was reversed as a matter of course.

But the Minerva and the Hyacinth have had their run, and although the policy was all decided in advance, and the Scotch boiler and the Belleville had already been condemned, we have some interesting information about the result, which might possibly have modified the report had the procedure been in a different order.

From accounts in *Engineering* and in *The Engineer* we extract data and results of the runs, which, although not official, are doubtless altogether accurate and reliable.

The two vessels are so nearly alike as to make the results fairly comparable, although there are slight differences which may be noted. The Minerva is 360 ft. by 54 ft. by 22¾ ft., and 5,600 tons displacement. The Hyacinth is 10 feet shorter, the same beam, and a little greater depth, and of the same displacement. The Minerva has eight cylindrical boilers and two funnels, the Hyacinth having eighteen Belleville boilers and three funnels, each vessel having two screws.

So far as evaporation is concerned, the Belleville boilers made a good showing. Three trials were made; at 2,000 h. p., at 5,000 h. p., and at 8,000 h. p., with the average result of 9.66 pounds of water per pound of coal for the Belleville and 8.73 pounds for the Scotch boilers.

The run to Gibraltar and back was rather a trial of the two vessels than of the boilers, and so far as speed goes, gives no information of value. So far as the general behaviour of the boilers at sea is concerned, however, it does give some information, although on a smaller scale than has already been obtained elsewhere. On the Minerva affairs were altogether uneventful, and barring the breaking of an eccentric strap, which was promptly replaced, there is nothing requiring comment. In other words, the Scotch boilers behaved just as they are behaving in countless merchant vessels making voyages in all parts of the world, steaming at their normal capacity, or with moderately assisted draught.

On the Hyacinth the customary state of affairs on vessels of the Royal Navy equipped with Belleville boilers, existed. At first all went well. Then began a mysterious loss of water, which it appeared impossible to trace. The evaporators were

called upon to their capacity of six to seven tons per hour, and yet no excess of water was found in the bilges or hot-well. Ultimately it was thought that a multitude of small leaks must have existed, and that the leakage evaporated and went up the chimneys. For this reason a careful overhauling of the boilers was made at Gibraltar, and the hydraulic test applied, although there is no reason why this should have been necessary after such a short run.

The most surprising thing about the trials was the promptness with which both vessels got up steam for the return start. One of the chief advantages of the water-tube boiler is the quickness in getting up steam, but in this case the Minerva was at full speed within two hours from the time of the signal for start, being but little behind the Hyacinth. The Scotch boilers behaved on the return run as steadily as when outward bound, while the Belleville varied the monotony by bursting a tube and scalding a fireman so severely that he had to be sent to the hospital upon arrival.

It will be seen that the trials lead to absolutely nothing new. The weak point of the Belleville boiler, i. e., its behaviour when forced, was not tried at all, and the run was far too short to form any serious test of endurance. The efficiency test, being largely mixed up with the performance of the engines, the vessels being differently engined, gives little useful information, since the superior evaporative power of one type of boiler was offset by the greater amount of water it had to evaporate for a given power, and the coal consumption was about 2 pounds per horse power in both cases.

If anything, the cylindrical boiler stands rather the better for the test, while the Belleville stands just where it did before. The one is steady, reliable, fairly economical, and a good steamer. The other is a good steamer, but is liable to slight leaks, annoying break-downs, and uncertain performances. Just what advantage it is to the Admiralty to find out these things all over again, remains to be seen.

In the meantime, there appears to be a way out of the present muddle which has been suggested before, but which has thus far not been acted upon, at least not in the Royal Navy. This is to use both Scotch and water-tube boilers in conjunction, employing the cylindrical boilers for regular cruising, supply of auxiliaries, and similar routine service. The water-tube boilers, which in this case should be of the small-tube express type, should be always ready for emergency service, capable of getting up steam at the shortest possible notice and able to produce a spurt of speed so vital to success in engagement. This arrangement was made several years ago in the United States coast-defence vessel Monterey, in which the Ward water-tube boiler was installed in connection with cylindrical boilers, and according to all reports, with excellent results.

Possibilities of Electrochemistry.

In the Presidential address of Mr. J. W. Swan, delivered before the Society of Chemical Industry at Glasgow, and published in the *Electrician*, the subject of electrochemistry is discussed at length.

The application of electrochemical methods in commercial work is largely a question of power, and cheap power must be a necessity so long as electricity is generated from chemical energy. Mr. Swan shows that while water power is generally the cheapest, yet in some instances the first cost of installation is so heavy that the interest burden makes it as costly as steam. As to the problem of producing electricity direct from coal, it must be remembered that any such method would involve the use of some form of cell, and that, judging from present experience in the handling of batteries, any form of cell would demand a greater cost for attendance and inconvenience than its advantages would warrant. The real source of cheaper electricity appears to lie in cheaper motive power, possibly in the utilisation of waste furnace gases in internal combustion motors.

Given cheaper electricity, and the influences upon electrochemical industries may be predicted. Cheaper electricity means cheaper calcium carbide and acetylene; the electrical decomposition of brine, with soda as the by-product and chlorine as the principal product. It means the possible fixation of atmospheric nitrogen, as already shown by Sir William Crookes, and the direct production of nitric acid and of nitrates. Carborundum and artificial graphite become suf-

ficiently cheap to displace natural competitors; aluminum falls in price to less than double that of copper by weight, and hence becomes cheaper per unit of electrical conductivity, and can displace the latter in many places as a conductor of current. These and many others must come with the advent of cheaper electricity, and will probably come in the very close future. Mr. Swan devoted attention to the importance of technical education in connection with the development of electrochemistry and its industrial applications, and urged the advancement of technical education, as one of the important objects of the society he was addressing.

Steam Turbine Vessels.

THE question of the adaptability of the steam turbine for marine service has been referred to many times in these columns, and to approaching completion of the King Edward, fitted with Parsons' steam turbines noted. We now have an account of the trials and regular running of this interesting vessel, and from reports in *Engineering* we give some abstract of the results.

The King Edward is 250 feet long and 30 feet wide, with a moulded depth of 10 feet 6 inches to the main deck, and 17 feet 9 inches to the promenade deck. She is designed for service on the Clyde, and with the exception of her propelling machinery, is similar to the best paddle steamers in the same service.

"The propelling machinery consists of three Parsons steam turbines working compound. These are placed side by side. In ordinary working, and when going ahead, steam is admitted from the boilers to the high-pressure turbine, where it is expanded five-fold. From thence it passes to the two low-pressure or wing turbines, placed one on each side, where it is expanded 25-fold, and then passes to the condensers. The total ratio of expansion is therefore no less than 125-fold. Each turbine has its own shafting; and on each of the wing shafts there are two propellers, while the central one carries only a single screw."

The wing motors alone are used with direct steam when manœuvring alongside a wharf, and there are small auxiliary turbines on the low-pressure wing turbine shafts for reversing purposes.

On the trial runs on the Firth of Clyde, a speed of 20.48 knots was registered, the mean revolutions being 740, and the boiler pressure being 150 pounds. Of course no indicator diagrams can be taken from this type of engine, but the horse power was estimated at 3,500 h. p.

The economical performance of the steam turbine has already been found, by trials of stationary engines under brake or dynamo load to be not greatly different from economical reciprocating engines, but as yet no economy tests of the *King Edward* have been made. During the regular running, however, it has been observed that the coal consumption is no greater, and possibly slightly less than other vessels of her class using reciprocating engines, and on this score the turbines appear to be satisfactory.

An important feature of turbine propulsion is the absence of vibration. The turbines themselves are entirely free from vibration and noise, and it is impossible on these points to tell whether they are running or not. On the *King Edward* a very slight vibration is felt directly astern, but this is due to the propellers, and not to the engines. This may possibly be eliminated, but as it now stands there is absolutely no vibration in the engines themselves.

Another feature to be considered in connection with turbines as marine motive power is the saving in weight. The weight of the motors, condensers, with water in them, steam pipes, auxiliaries connected with the propelling machinery, shafting, propellers, etc., is 66 tons. This is estimated to be about one-half the weight per indicated horse power of the average of the propelling machinery of paddle boats of a similar type. Owing to this light weight of machinery it has been possible to give a very fine shape to the hull. The model was tested very thoroughly in the experimental tank of the builders, Messrs. Denny, at Dumbarton, and the result is evident in the finely tapering lines at the bow and stern.

Altogether this installation should do much to demonstrate the adaptability of the steam turbine for vessels of a larger size than the torpedo boats and destroyers to which it has hitherto been fitted. Next we may expect the equipment of Channel steamers, and from that to transatlantic steamers is but a step.

Coal Dust Explosions in Collieries.

EXPLOSIONS in collieries are generally due to the presence of firedamp, although the explosive nature of intimate mixtures of coal dust and air is well known. The relation of coal dust to permitted explosives in mines, however, has not had the attention which it deserves, and hence the paper of Mr. James Ashworth, in a recent issue of the *Colliery Guardian*, is of interest.

The direct occasion of Mr. Ashworth's paper was the explosion of coal dust in the Walthew House Colliery, due to the attempt of a fireman to break up a cog wheel with a charge of roburite, in order that it might the more readily be removed from the mine. The explosive employed in this case was one of the so-called flameless explosives, of high-class, having successfully withstood all government tests and being legalised for use in mining under well-known rules. Nevertheless, its use in this case was followed by a violent explosion, in which four men lost their lives, and the subsequent investigations established beyond question that the explosion was due to coal dust.

In examining the possible causes for the ignition of the coal dust by an explosive which had been found safe for use in the presence of firedamp. Mr. Ashworth advances a theory which appears sound, and which demands the attention of all who have to work in dusty mines. Assuming the absence of actual flame, or of firedamp, he shows that in this, and in other smilar cases, the explosions were due to the ignition of the dust by the intense heat produced by the sudden air compression produced by the force of the explosive.

That heat is caused by the compression of gases is well known. Wherever air is used under pressure means must be provided to carry away the heat. The cylinders and valve chests of air compressors are water-jacketed, to prevent the heat from attaining a point which would ignite the lubricants, while in certain petroleum motors the heat of compression is relied upon entirely for the ignition of the charge every stroke.

"But we must note that it is the speed with which the air is compressed that may cause the intense heat, and not necessarily the volume which is compressed; thus in the case of an explosion in the air receiver of a compressor, the pressure of the air was only 45 pounds per square inch, and yet the heat close up to the outlet valves was 550° F., and although the oil used for lubricating had a flash point of 600° F., yet by only slightly increasing the speed of the engine two explosions occurred in the short space of eighteen months. Gas is readily given off from coal dust, and it is merely necessary to accelerate the oxidation by heating the dust in contact with air to a temperature likely to be reached in compressing air to 58 pounds per square inch, to bring about the ignition of dust. Professor Bedson proved, when experimenting on coal dust after the explosion in the receiver and air pipes at Ryhope, that the ignition point of coal dust was between 291° and 320° F., and that also when coal dust was under pressure combustion was vivid and had a higher temperature than when the experiment was made under ordinary pressure."

These views receive practical confirmation in connection with the experiments made by Herr Diesel to use coal dust directly in cylinders of his internal-combustion motor. The heat of compression was found amply sufficient to ignite and maintain the coal dust in combustion without the use of any other igniting device. Diesel's experiments also showed that the temperature of ignition was materially lowered by compression, which is also in accordance with the observations upon colliery explosions.

"In connection with the Ryhope compressed air explosion there was another point which does not appear to have received any attention at the time, nor yet since, viz., that the explosion in the receiver started a wave of compression, which produced a sufficiently high temperature to cause the generation of combustible gases in the pipes in the shaft and roadway, and in this way the temperature and the pressure were increased until the wave of compression reached such a point of intensity that it caused an explosion which exerted stupendous effects at a distance of 400 yards from the receiver."

The importance of this question of possible ignition from compression should especially be considered in connection with

dusty mines when it is remembered that while a temperature of about 667° C. is necessary to ignite firedamp, only 145° C. with pressure is necessary to ignite coal dust. It appears to be useless to attempt to prevent the presence of dust by sprinkling, as the presence of moisture adds to the force of the explosion.

The Transverse Strength of Ships.

AMONG the papers presented at the recent meeting of the Institution of Naval Architects may be mentioned one by Mr. J. Bruhn upon the transverse strength of ships, which, both from the importance of the subject and the manner of its treatment, demands review.

Nearly all the discussions of the strength of ships have been made with reference to the longitudinal strength, and indeed when the calculated strength of a vessel is mentioned it is always assumed to refer to the longitudinal strength. So far as the quantity of material used in construction is concerned, this is doubtless natural, since the longitudinal bending moments are so much larger than the transverse ones, as to have a far more important influence upon the material required.. When considerations of safety are taken into account, however, no one part of the ship can be considered of more importance than another, and if damage occurs, it is no excuse to say that the vessel was of ample strength longitudinally.

Mr. Bruhn proceeds to examine the subject graphically and analytically, and while we cannot go into the details of his analysis in this place, some idea of his method may be given.

Longitudinal girders present little scope for variation in design, and the breadth, depth, and form being practically given, the only opportunity for varying the strength lies in modifying the thickness of the plating. In the case of transverse framing, however, the efficiency, or strength, lightness, and compactness, of the structural arrangement, depends to a great extent upon the form and arrangement of the material. Since the case is more complicated than in the design of longitudinal framing, while at the same time greater variation is possible, it will be seen that the opportunities for the application of scientific principles are correspondingly greater.

Transverse stresses may be defined as those which act to change the form of the cross section of a ship. These are directly due to forces acting transversely and indirectly to forces acting longitudinally. These forces may be determined with a greater or less degree of accuracy, according to circumstances. The weights of structure and cargo, together with their reactions, due to rolling, pitching, or heaving can be closely determined; the weights exactly, and the reactions accurately by experiments in still water, or roughly by considering only the failures and successes of actual structures. Taking such a structure as a vessel floating freely in water, all the forces acting upon it can be determined when the conditions are known. In practice the forces must be based upon the assumption of the worst possible case which the vessel can be supposed to meet. The task of the designer then consists in apportioning the work of resisting these forces to the various parts of the structure.

Mr. Bruhn proceeds to investigate the problem by supposing a section of one frame space in length, cut out of a ship, and examining the forces necessary to keep it in equilibrium under the given conditions. In the case of a simple section, such as that of a small single-deck vessel, without pillars, floating freely in still water, the problem is a comparatively simple one. In order that the ring formed by the outline of the section shall be in equilibrium, the weight of the structure and the cargo, the pressure of the water, and the bending and direct stresses on the ring, must balance each other. The problem thus becomes one of statics, and is solved as such. When, however, the resistance of beams and framing are also to be considered, the problem becomes more complicated, and Mr. Bruhn considers the most direct method of solution to be that based on the principle of least work. This method, although largely applied to general framed structures since its introduction by Castigliano, has not heretofore been used in connection with the design of ships although it possesses many advantages for that purpose.

It is impossible to go into the mathematical details of the application of the

method to the distribution of stresses in ship framings here, but its use is clearly shown by Mr. Bruhn in fully worked-out examples. The cases examined include designs with single decks and with two decks, with and without rows of pillars between the centre and the side, and the extension of the method to vessels with any number of decks and pillars is shown to be altogether practicable.

Among other things the analysis shows the important part performed by transverse bulkheads in increasing the athwartship strength.

Their effect, being transmitted to the frames through the shell plating, deck plating, and stringers, will prevent racking so long as the spacing is close enough to prevent the plating from bending appreciably.

The most important feature to be considered after the application of the method is understood, lies in the proper estimation of the forces. The original computations are made upon the basis of the steady pressure of the water when at rest. The stresses will necessarily be greater when a ship is at sea, rolling and subjected to blows from waves. The horizontal pressure of the water being by far the most important force acting on the frames of a vessel, it is desirable to ascertain as far as possible what it will be under the worst conditions met at sea. The experiments of Stevenson, made in connection with lighthouse construction showed blows as high as 3 to 3½ tons per square foot striking a rigid wall or rock. As the force of a blow cannot be stated, however, with any practical value unless the yield of the body struck be also given, these figures are hardly available. Mr. Bruhn estimates, from the strength of rudder-stocks which have been broken by striking seas, that the force may be safely taken as about .2 ton per square foot, but he suggests that experiments upon the subject be made.

The Measurement of High Temperatures.

In view of the increasing use of high temperatures in the arts it has become more and more imperative that some convenient and accurate method of measurement should be provided, and the solution of this problem has occupied the attention of many able investigators. Ever since the time of Wedgwood it has been realised that products which are obtained by the action of heat often have their value materially affected by comparatively small variations in the temperature to which they have been subjected, and apart from the interest which the question of the accurate determination of high temperatures possesses for the scientific investigator, it will thus be seen that the subject has a great technical and commercial importance.

The recent development of electric pyrometers shows that much has been done in that direction towards the definite solution of the problem, and hence the exposition of the construction and operation of these instruments in papers by Mr. W. Rosenhain, in recent issues of the *Electro-Chemist and Metallurgist* are of interest and value.

"Electric pyrometers may be divided into two classes, according to the electrical effect of heat upon which they depend. One class depends upon the effect of heat to raise the resistance of a wire; these are resistance pyrometers. The other class takes its indications from the current generated by heating one of a pair of junctions; these are the thermo-electric pyrometers. Each of these electrical effects of heat may utilised for the measurement of high temperatures in two ways. The resistance wire or the thermo-couple may either be placed directly in the furnace, at the very spot the temperature of which it is desired to determine, or it may be exposed only to the heat radiated by the body of which the temperature is to be measured. The former method is much more direct, sensitive, and satisfactory wherever it is available, but the difficulties with which it is attended increase rapidly when the temperature to be measured exceeds 1,300° C. For the excessively high temperatures met with in electric furnaces, however, the radiation method must be resorted to, as the most refractory materials are fused by such heat, with the sole exception of carbon. It may ultimately be possible to construct a thermo-electric junction of two varieties of carbon which will stand the heat of the electric arc, but so far no such couple is known. The measurements of these very high temperatures by radiation methods

are unsatisfactory for a number of reasons, but chiefly because we cannot calibrate our instruments at these temperatures, except by extrapolation, which has to be carried so far as to render the results of very little value.

The electric resistance pyrometer, originally suggested by Dr. Siemens in 1871, consists of a platinum wire about a metre in length, and 0.1 mm. in diameter, wound about a cylinder of porcelain, and placed in a suitable position in the furnace. By making the hot platinum resistance a part of a battery circuit in parallel with a known resistance kept at a constant temperature, the variations in temperature would be indicated by the variations in resistance, the measurements being made either with a voltameter, or a galvanometer. A serious difficulty which soon appeared with this instrument was the variation in the resistance of platinum. Instead of remaining constant, the resistance increased after each heating, thus requiring the instrument to be re-calibrated after each using.

This difficulty has been largely obviated by Griffiths and Callendar, it having been found that perfectly pure platinum, completely protected from the chemical action of metallic vapours or the contact of clay or other siliceous matter in a reducing atmosphere, and properly insulated, will remain practically of constant resistance. The improved Griffiths and Callendar resistance pyrometer, with the ingenious recording apparatus of Professor Callendar, is now a commercial instrument, well adapted for many operations, but it is desirable that the resistance of platinum of high temperatures be more precisely determined than is now the case.

The thermo-electric pyrometer depends upon the fact that when two different metals are joined and heated at the point of junction an electric current is produced in the circuit of which they form a part. Such devices were studied by Becquerel, Regnault, Pouillet, and others, but it remained for Le Chatelier to produce a reliable instrument upon this principle. In the Le Chatelier pyrometer two wires, one of pure platinum and the other of platinum alloyed with 10 per cent. of rhodium are soldered together at one end, and inserted into a porcelain tube. The free ends are connected to a galvanometer, and the deflections measure the heat to which the wires are subjected.

Mr. Rosenhain discusses especially the Roberts-Austen pyrometer, which consists of the Le Chatelier thermo-electric couple, connected with a photographic recording device. A mirror on the galvanometer throws a beam of light upon a moving surface of sensitised paper, or in the more refined instruments for laboratory work, upon a sensitive photographic plate, thus recording every variation of current and temperature accurately.

By the use of very sensitive galvanometers, and a rapidly moving sensitive photographic plate in the recorder, together with the employment of a differential method of observation, Sir W. C. Roberts-Austen has obtained some remarkable records showing the arrest points and phenomena of recalescence in cooling metals.

Various practical difficulties, however, appear in connection with the practical use of electric pyrometers. The refractory substances used to protect the wires from the chemical action of vapours in furnaces becomes softened at temperatures above about 1,400 degrees C., and many insulating materials, as shown by Nernst, become electrolytes at high temperatures.

"With these difficulties before us, it must be admitted that the problem of obtaining continuous records of furnace temperatures much above 1,200 degrees C. is not yet satisfactorily solved; but the instruments that have been described are evidences of the valuable help that electrical science has given to the study of high temperatures and to the arts and industries involving their use."

The Limitations of Electric Traction.

In the introductory lecture of Cantor lectures on electric railways, recently delivered before the Society of Arts by Major Cardew, and published in the *Journal* of the society, there are given some interesting views as to the proper place for electric traction for railway transport.

"Under what conditions, and for what reasons does it cease to be preferable to the existing system of steam locomotion?

"The two systems differ so radically, inasmuch as in steam locomotion the power is entirely self contained, whereas the electric

train derives its propelling power from an outside source, that we instinctively feel that there must be a field for each method, especially since the self-contained system has beaten all systems analogous to the electric under all conditions of traffic, and it is only in consequence of its great superiority to any other known system of transmission of power that electricity can claim to compete with steam in the field of railway working."

The matter may be considered from two viewpoints: that of the travelling public and that of the railway companies. The traveller can hope for no very great advantage from the substitution of electricity for steam on long distance express journeys. There might be less discomfort in tunnels and a little time might be saved in stops, but otherwise there is little or nothing to be gained. It has been claimed that greater speeds can be attained with electric driving than with steam, and while this is true, yet it is doubtful whether speeds of 100 to 120 miles an hour can be made to pay, within the limits of the British Isles.

"When we regard the traffic arrangements on the lines communicating between important towns not exceeding 100 miles apart and their branches, however, the possibilities of improvement from the introduction of electric traction and of the new methods of working traffic which must accompany the change, become far more considerable."

The two methods differ entirely in principle. The problem of conveying a given number of passengers between two places is economically solved with steam traction by means of a limited number of heavy trains at considerable intervals; while with electric traction the most advantageous method is that of light trains at frequent intervals. For short journeys, say of two hours or less, the advantages of a frequent service at fixed intervals are very considerable. The electric system, however, requires a totally different method of operation from steam locomotion. It involves not only the electrifying of the line, but also the electrifying of the traffic arrangements. It is these latter changes which doubtless cause many managements to hesitate, rather than the engineering details of the change of motive power. If the public will respond promptly and fully, the cost of the greatly enhanced travelling facilities, would not stand in the way, but as it is, many directorates hesitate to take the plunge.

"Steam traffic has been evolved from the stage coach, and bears the unmistakable impress of its descent. Electric traction tends towards the ideal of the continuously moving platform."

Viewed from the standpoint of the railway companies, the whole question is resolved into one of finance. The conditions of electric traction point to greatly increased receipts, due to improved service and increased earning capacity. With this, however, comes greatly increased expenditure; partly due to capital expense, which can be easily computed, but largely due to increased working cost, a less definite item.

Major Cardew examines at length the points in favour of electricity as a motive power for a frequent service of light trains, taking his data largely from the paper of Mr. W. Langdon before the Institution of Mechanical Engineers, reviewed in these columns in January 1901, as well as the paper of Mr. Boynton before the American Institute of Electrical Engineers, reviewed here in April 1900. The general conclusion is undoubtedly in favour of electric traction under the conditions above stated, i. e., for journeys of about 2 hours or less in time, where the traffic will warrant the running of frequent light trains.

It must not be forgotten that the advantages gained by the high speed on the road, are often neutralised by the waste of time involved to the traveller by the system of trains from single terminals at long intervals. The loss of time, due to the distraction from business affairs, necessitated by the catching of a particular train, is entirely avoided by the knowledge that connection may be had every 10 or 15 minutes at a neighbouring station. It is the actual time between the passenger's home and destination, not between the railway terminals, which really counts.

The electric railway may never supersede the steam railway for long-distance express service, but for inter-urban service, within 100 miles distance, it will probably displace steam as completely as it has already displaced horse traction for municipal and suburban tramways.

Water-Tube Boiler Connections.

ONE of the most important features in water-tube boiler design is the manner in which the tubes are connected to the collectors and water drums, and upon the method of connection employed depends to a great extent the important features of safety, strength, circulation, and ease of assemblage and repair. For this reason a paper by M. C. Walckenaer, in a recent issue of the *Revue de Mécanique*, demands attention, treating as it does, upon the development of the various methods now in use.

Water-tube boilers, as the name implies, consists mainly of assemblages of tubes filled with water and exposed to the action of fire and heated gases. In them the steam is generated, and every facility should be provided for the escape of the steam to the point where it is delivered for use, equal facility being given to the access of water. It is evident that connections for tubes for such service have to fulfil severe requirements. The joints are many and close together, and commercial economy demands that the cost shall not be great. Steam pressures are creeping steadily upward, and 250 pounds per square inch is a not uncommon requirement, while at the same time rapid firing and sudden demands for steam make expansion and contraction strains frequent and severe. The necessity for prompt and convenient replacement of burst or leaky tubes demands a joint which can be easily broken and re-made, and, what is still more difficult, will be as tight as ever when re-made. All these requirements must be met, not only when the work is done in the works of the maker by skilled mechanics using special tools, but also, and frequently, in the stokehold of a vessel, many miles from port and with such help as can be obtained under such conditions, or, even in the midst of battle at a time when the fate of the engagement or the vessel may depend upon the promptness with which the joint can be handled.

M. Walckenaer begins with the Collet joint, a predecessor of the Niclausse system, this being a concentric tube system in which a taper joint was made between the front end of the tube and the collector by means of a long through-bolt, this bolt also serving the make the connection for the caps at each end, and apparently suggested by the similar bolts used long before on the Harrison system of cast-iron spheres. This was subsequently replaced by a short bolt engaging with sockets in the forward end of the tube, the back end being closed entirely, or fitted with a screwed cap.

The desirability of providing for the withdrawal of the tubes from the front, however, caused this arrangement to be reversed in the present form of the Niclausse boiler, and the sleeves are now forced in from the front, one yoke and bolt serving for two adjacent sets of tubes. In this design the tubes were originally attached to the sleeves by a screw joint, but there have been several accidents due to the separation at the screwed joint, and in the latest pattern the sleeve, with the two conical joint-surfaces, is formed in one piece with the seamless tube. The rear end of the Niclausse tube is closed by a screwed cap, but as this joint is not exposed to the action of the fire, no difficulty is apprehended at that point and no failures have been reported.

The above methods all relate to boilers having tubes connected to the collectors at but one end, and provided with internal circulating tubes on the Field principle, and they are manifestly unsuited for tubes connected at both ends. The Belleville boiler, one of the oldest in this matter, M. Belleville having been experimenting since 1856, uses screwed joints, the steel connecting boxes being fitted with a thread of 2.5 mm. pitch, while the screw-thread on the tubes is 2.54 mm. pitch, this slight difference in

pitch insuring a tight joint. A back nut is also used on the tube, red lead being applied before screwing up. This sort of a joint is difficult to disconnect after having once been properly made up, and in the Belleville boiler it is customary to remove an entire element and replace it with a new one, when any tube reveals defects. If a single tube must be replaced the back nut is usually cut off, and even then the tight differential joint is sometimes hard to disconnect.

Expanded joints are generally used in the small-tube express boilers, and also in some of the large-tube boilers such as the Babcock & Wilcox, De Naeyer, and others. These joints, made by expanding the ends of the tubes by the use of a roller expanding tool until a shoulder is formed against the metal of the collector or header, have long been employed in the construction of multitubular "tank" boilers, and although they do not meet wtih the full approval of M. Walckenaer they appear to be the most practical form at present in use, although something better is undoubtedly to be desired. Single tubes can be cut out and new ones expanded into the same holes, and if the work is intelligently done the new job will be as good as the old one. This may not be saying a great deal, but it is more than can be said of screwed or taper joints, or in fact of any form of joint now known, except the finished metal-to-metal joint, used in some older types of boilers and now abandoned because of its cost.

M. Walckenaer discusses the various forms of joints used for caps, and his paper is a thorough résumé of this most important detail of water-tube boiler design, and it is to be hoped that it will stimulate steam engineers to effect further improvements in a ripe field.

The Iron Industry of the Southern Urals.

THE development of Russian metallurgical industries continues to fill an important portion of the field of technical interest, and from a paper presented before the Société des Ingénieurs Civils de France by M. Alexandre Gouvy, and published in the *Mémoires* of the society we take some account of the methods and products of the iron industry of the southern Urals.

M. Gouvy, who is the director of the Komarovo iron mines and furnaces near Avzianopetrovsk, is especially well fitted to discuss the work of this important district and to show its possibilities and needs.

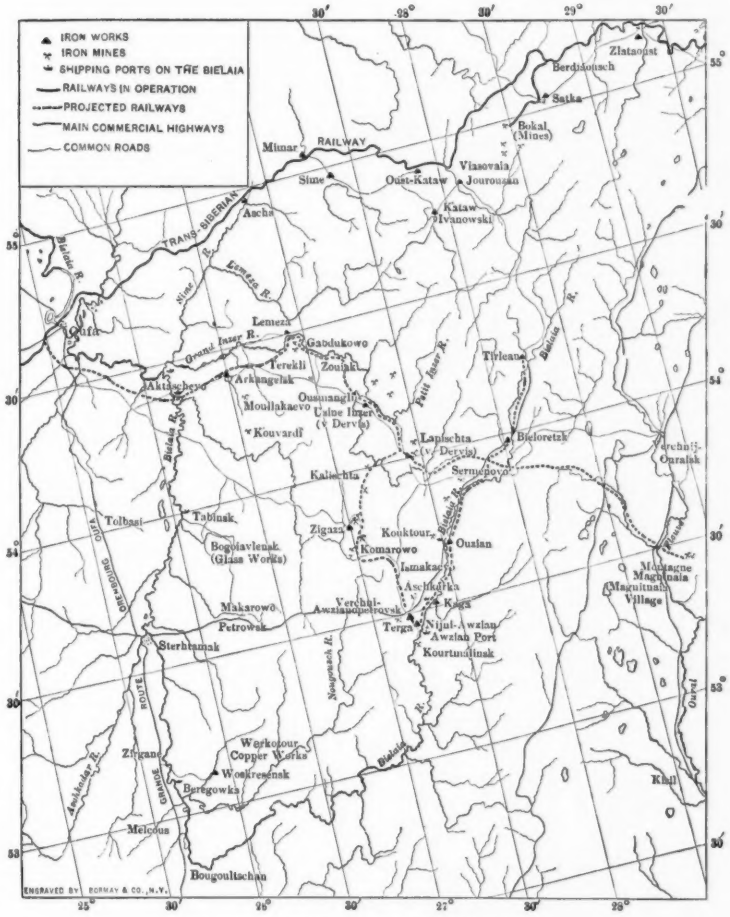
The Southern Ural comprises that portion situated between the 53rd and 55th degrees of latitude, south of the main line of the Trans-Siberian railway, running from Samara to Tcheliabinsk. In considering this important region it must be remembered that the conditions are wholly different from those obtaining in the central and northern Usal districts. There are no railways in the southern Urals, and the only available fuel is wood from the Bashkir forests, while in the more northern sections the mines and iron works are in connection with railways and navigable rivers, and are operated in connection with proprietary forests, or with forests held under long government leases As a result of this isolation, the conditions vary at each furnace, and the cost of the product fluctuates with the weather, with the price of oats and corn, and with the supply of labour and of horses.

Notwithstanding these difficulties this inaccessible region at present maintains 17 blast furnaces of a capacity of 6,000 to 12,000 tons per year, the total being more than 150,000 tons of pig iron.

M. Gouvy discusses in detail the methods of manufacture and the difficulties with which the iron works have to contend, mainly for the purpose of showing how vastly the output of the region would be increased if suitable transportation facilities were afforded. We can only give space here to a brief résumé of the present methods. as the important feature of his presentation of the subject lies in the exhibit which it gives of the wealth of the district and its future iron-producing capabilities.

The geographical location of the various iron works in the district is shown on the map, as well as the iron mines and the present limited means of transport. The map shows also the existing railway communications, and the proposed lines, which if completed will open up one of the richest iron mining sections in Europe.

The ores of the district are mainly brown hematite, found in strata ranging from 60 to 120 metres in thickness, and



THE IRON DISTRICT OF THE SOUTHERN URALS.

readily uncovered and worked from the surface.. The gangue is schist and clay, and roasting is found necessary before the ore is suitable for the furnace. In the western portion, close to the Siberian border is found the mountain Magnitnaia, consisting almost wholly of a very rich magnetite, containing 63 to 65 per cent. of iron. This ore has as yet been used only by the Bieloretzk furnace, solely because of the difficulties of transport to other furnaces, and indeed the riches of this section are as yet very imperfectly realised. The brown hematite is low in phosphorus (0.02 to 0.06 per cent.) and contains about 53 per cent. of iron.

These ores are at present worked entirely by manual labour, the Russian peasants coming from the villages, sometimes from a distance, bringing their families, horses and sledges, the men digging out the ore, the children leading the horses and sledges from the mines to the furnaces, while the women work in the woods. With these crude methods, the ore costs from 3.13 to 5.44 francs per ton, of which 60 to 80 per cent. is due to mining and hauling, and could be enormously reduced by the

employment of steam shovels and railway transport.

The fuel is invariably charcoal, made in the surrounding woods, from the pine and birch, the beech, so generally employed in making charcoal in the iron districts of Hungary, being almost entirely absent. The charcoal burning is mainly the work of the Bashkirs, the semi-Tartar people who form the principal population of the region. The greater portion of the forests belong to these people, having been ceded to them by Catherine II, under the jurisdiction of the forestry department of the government, but the extent and nature of the region makes it practically impossible for the government to exercise any control, and great waste continues in the exploitation. The wood is charred in ovens, or in heaps and hauled to the furnaces on sledges in a manner similar to the ore, the cost necessarily varying greatly according to local conditions.

The furnaces are of moderate size, depending upon the capability of the charcoal to sustain a burden, and are constructed mainly of local materials, the cost of transport having an important bearing upon everything. This same question of transport has influenced the character of the machinery, the blowing engines, mainly of German make, being of high speed in order to reduce weight, and sectional boilers, of the Babcock & Wilcox type, being used.

At the present time the traffic of this important iron region is entirely confined to the river Bielaia, with the exception of a trifling portion from Tirlean, carried on camels. The shipments on the Bielaia are made once a year as soon as possible after the melting of the snows, usually in April, the barges being constructed for each voyage, and being broken up and sold for building or fire-wood when the ports of destination are reached. These barges are 40 to 50 metres long and 10 metres wide, and in the upper waters of the Bielaia carry 10,000 to 15,000 poods (16 to 25 tons), while below Beregovka, loads of 40,000 poods (about 65 tons) may be carried. For these reasons the works at Kaga-Bieloretzk and Avzianopetrovsk are obliged to haul a portion of their output as far as Sterlitamak or Tabinsk, in order to complete the loading of their barges.

A number of railway projects have been made to open up this important region, and the proposed routes are indicated on the map. Especially is it desirable that the mines at Magnitnaia be placed in rail connection with central and western Russia. From Oufa, on the Trans-Siberian Railway, to Magnitnaia is 350 versts, about 232 miles, while with the branch railways to the various mines and furnaces the total length of railway required will reach 500 versts, or 330 miles. The cost of the road is estimated at about 37,500,000 roubles, an amount probably only obtainable by government assistance, but the immense gain to the available riches of the empire resulting from the opening of this important region appears to make the expenditure ultimately advisable.

Tests of Masonry Piers.

SEVERAL years ago the Austrian Society of Engineers and Architects made a very important series of tests of full-sized arches of brick, stone, and concrete, and the report of these trials, together with the accompanying analysis, proved a most valuable contribution to engineering literature. This work has now been supplemented by some important tests upon the strength of masonry piers, the tests being made under the supervision of the same committee which conducted the arch tests, the results being published in a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines.*

The tests were made in all cases upon piers one-half metre square in cross section and one metre in height, the pressure being applied by means of a 1,200 ton hydraulic press at the Poldihütte at Kladno. The report gives an illustrated description of this press, which was originally constructed for forging steel, and which had already been employed for testing on similar work by Herr Ludwig Huss, former member of the arch-test committee. The press was carefuly calibrated to determine its internal frictional resistances, and the gauges upon which the pressures were read being also calibrated it was possible to determine the true pressure upon the test piers very closely.

Various kinds of piers were subjected to the tests, for the details of which the reader

must be referred to the original report. Among those tested were piers of granite, sandstone, concrete, common and reinforced, and brick. The reinforced concrete construction was tested in two different types, one having imbedded in it vertical wire rods 12 mm. in diameter, and the other containing wire cages, of which the principal members were parallel to the surfaces of pressure. In all cases much care was taken to insure that the load should be central, with the exception of certain tests which were purposely made to determine the effect of eccentric loading. The records were taken at the moment of the appearance of the first cracks, and at the time of ultimate crushing, these results being fully tabulated in the report.

The tables are very full in details and but a few results can be given here. Thus a pier of hard bricks laid in Portland cement sustained, after six months, a load of 1,365 pounds per square inch before cracks appeared, and crushed under 2,275 pounds. Granite blocks, laid in Portland cement, crushed under 8,100 pounds per square inch, while piers of sandstone rubble, laid in Portland cement, showed cracks under a load of 2,750 pounds, and crushed under 3,200 pounds.

The most interesting tests, however, were those which showed the resistance of ordinary and reinforced concrete piers. A pier of solid concrete after 3½ months, crushed under 1,780 pounds per square inch, the rupture taking place almost without warning cracks. A similar pier, reinforced by the insertion of vertical wire rods held together by circumferential bands, and tested also after 3½ months, stood a pressure of 2,470 pounds per square inch before the appearance of cracks, and crushed only after the application of a load of 3,800 pounds. Even then the pier did not altogether give way, the core remaining partially unbroken. The results of these tests showed the importance of placing the metal reinforcement where it can act to the best advantage. A moderate increase in the strength of the circumferential bands, would have added greatly to the strength of the whole pier without adding appreciably to the cost, while the large margin of strength remaining after the appearance of the first cracks shows how structures constructed on this principle may be made free from sudden disaster.

The care with which these tests were made, and the fullness with which the results are recorded, render this report a valuable document, worthy of association with the large report of the same committee upon arch tests, and it adds one more to the many contributions to engineering knowledge by the Austrian society.

Binary Vapour Engines.

THE recent experiments of Professor Josse, of the Charlottenburg Royal Technical High School, upon his improved form of binary vapour engine, have attracted much attention, and the whole subject is one which demands discussion in view of the prominence which has been given to it of late.

The idea of using the heat contained in the exhaust of a steam engine to vaporise a more volatile liquid than water, the second vapour to be employed in a second engine, appears to be due to Sir Humphrey Davy, but he made no attempts to put the idea into practice.

In 1830, Ainger suggested the use of ether as a secondary liquid in connection with steam, and about 1850 du Trembley constructed several such engines, and demonstrated their operative success in vessels plying on the Mediterranean.

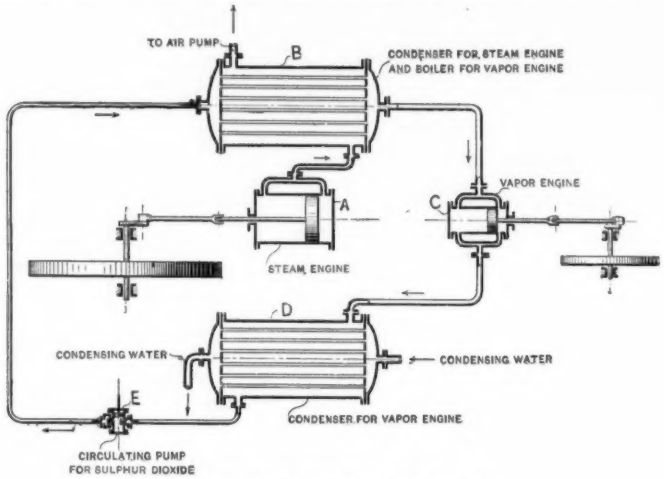
Briefly, the principle of the binary vapour engine is that of delivering the exhaust steam from a steam engine into a surface condenser, the cooling surface of which is in contact with the volatile liquid. The steam is condensed, thus producing a vacuum for the steam engine, while the volatile liquid is vapourised and its vapour produces sufficient pressure to run a second engine. The exhaust from the second engine is condensed in a surface condenser, using water as the cooling agent, and the condensed liquid is pumped back again into the vessel in which it was vapourised.

Du Trembley made several engines on this plan, maintaining that all the power obtained from the ether engine which he used was clear gain, having been generated from the waste heat in the exhaust of the steam engine. In view of the non-economical character of the steam engines with which he experimented, there was doubt-

less sufficient waste energy in the exhaust to make it worth utilising, but the mechanical difficulties connected with the ether engine, such as leakage, defective stuffing boxes, etc., made the system impracticable, and the report of the French Government Commission, given in abstract in Bourne's "Steam Engine," shows the causes which led to the abandonment of the method at that time.

Professor Rankine, in his classical treatise on the steam engine, examines the theory of the binary vapour engine at length, with a study of indicator diagrams; taking his data for the ether engine from a cylinder so large as to be more costly than the binary engine."

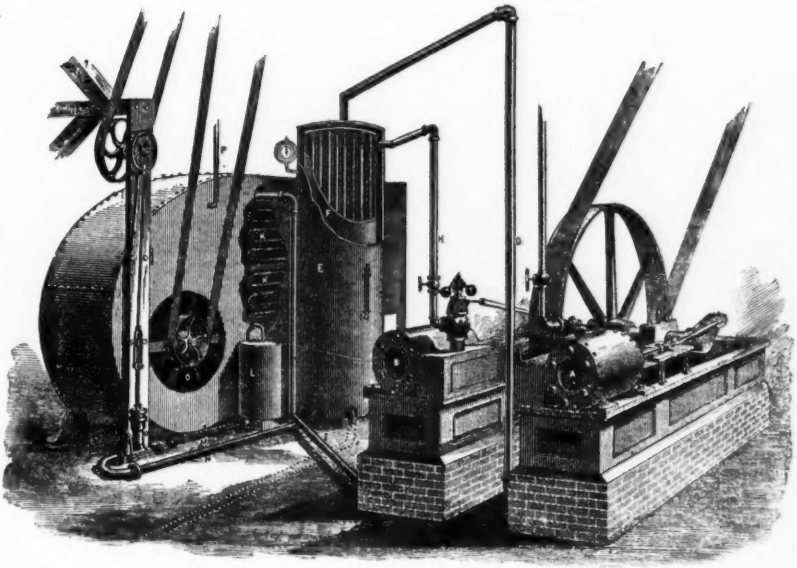
The idea then remained dormant until about 1870, when it reappeared in America as the Ellis Combined Vapor Engine. The principal difference between the Ellis system and its predecessor lay in the use of bisulphide of carbon instead of ether, but the principle remained unchanged. Ellis and his associates showed much ingenuity in the working out of details, and several engines were built and operated with success, but while the steam consumption of ordinary engines to which the bisulphide engine was connected, showed a decided



SCHEME OF THE JOSSE BINARY ENGINE.

M. Gouin's report of the performance of the du Trembley engines on the steamship "Brésil," in which a minimum fuel consumption of 2.44 pounds of coal per horse-power-hour was attained. His conclusion may be quoted here: "The binary engine is not more economical than steam engines designed with due regard to economy of fuel; but by the addition of an ether engine, a wasteful steam engine may be converted into an economical binary engine. The same amount of additional energy which is obtained by the addition of an ether engine to a steam engine might also be obtained by continuing the expansion of the steam sufficiently far, provided a sufficiently low back pressure could be insured; but this might require in some cases economy, in no case were better results attained than with the use of steam engines working over the same range of temperature. The system was abandoned, we believe, after a disastrous explosion of bisulphide vapour.

During the past few years experiments have been made by Professor Josse at Berlin, with a binary engine in which sulphur dioxide is employed as the secondary vapourised liquid. Professor Josse has published a very interesting account of his experiments on apparatus in the *Mittheilungen aus den Maschinen-Laboratorium der Kgl. Tech. Hochschule zu Berlin*, and as a company has been organised for the development of his ideas on a commercial scale, the subject demands re-discussion.



THE ELLIS BINARY ENGINE, AS OPERATED IN 1873.

Since the experiments of du Trembley and of Ellis, much experience has been gained in handling vapours of volatile liquids, such as sulphur dioxide and ammonia, in connection with refrigerating machinery, and this has rendered it possible to overcome constructive difficulties which gave the earlier experimenters much trouble. In other respects the apparatus of Professor Josse is surprisingly similar to that of Mr. Ellis, so much so that one must express admiration at the work of the earlier engineer, who, more than 30 years before, showed such a full appreciation of the nature and difficulties of the problem.

The general arrangement of the Josse apparatus at the Charlottenburg Technical High School is well shown in the diagram, which practically explains itself. The steam engine was a triple expansion engine, working with steam superheated 300° C., and developing about 150 h. p., with a steam consumption of about 11.15 pounds per h. p. hour. The sulphur dioxide engine added about 33 per cent. to this, and gave a total steam consumption of about 8.34 pounds per h. p. hour.

While this is an excellent showing for a combination of such a moderate total power, yet, after all, it is no lower than has been obtained with modern steam engines of about the same power, using superheated steam. Thus the Schmidt compound engine, using steam superheated only 150° C., has shown a steam consumption of only 8.36 pounds of steam per h. p. hour, without any of the complication of the binary vapour engine, and the added cost of the superheater is hardly as much as that of the second engine and condenser, and indeed at Charlottenburg the superheating apparatus was also used.

The opinion of Rankine, therefore, still holds good, and the economy of the binary vapour engine is about the same as that of the most economical steam engines without the use of the second liquid and engine. Professor Josse gives examples of the manner in which the sulphur dioxide engine has been used advantageously to add to the power and economy of existing engines which were not giving the highest results, and it is in this field that his apparatus may look for its commercial results rather than in the installation of new plants. This again is in full accordance

with the opinion of Rankine, quoted above. As a matter of historical interest we reproduce the illustration of the apparatus of Ellis, taken from his pamphlet of 1873, showing it as it was running and tested at that time. It is interesting to note the close resemblance between the two systems, and also to observe that Ellis used the evaporative condenser in order to economise condensing water, a device only now coming into use in connection with steam engines.

Modern Turbine Construction.

WITH the development of the electrical transmission of power has come a great increase in the utilisation of water power, and in no country has this been more noticeable than in Switzerland. The review, therefore, of the turbines and regulators, exhibited at the Paris Exposition, recently appearing in successive issues of the *Schweizerische Bauzeitung* from the pen of Professor Franz Prásil, and now issued as a *Sonderabdruck* of that journal, demands notice at this time.

It is difficult to give a review of this character a form altogether different from that of a mechanical catalogue, but there are certain principles which can be discussed all the better because of the presence of concrete examples, and in this case the most has been made of the opportunity.

Broadly, the wheels exhibited may be divided into three classes: turbines for low and moderate heads, these being almost all designed on the Francis model, with slight modifications; turbines for medium and high heads, on the Girard type; and turbines for high heads on the Pelton type. For the first class, the gates being large and heavy, the regulators are nearly all operated by means of auxiliary motors, controlled by centrifugal governors. The auxiliary motors are in some cases hydraulic cylinders operated by the direct pressure of the water, but in most instances derive their power from the shaft of the turbine itself. The centrifugal governor throws into gear a screw or worm-wheel movement, in either direction, according as the speed is to be increased or diminished, or else it is connected to a pawl and ratchet gear which acts in a similar manner. This form of regulator shows a tendency to overrun, thus making too great a correction, and hence it is provided with a differential gear, which acts to throw the auxiliary power out of gear promptly unless followed up by the governor; and by a careful regulation of the relative action of the two portions of the differential connection, overrunning can be almost entirely avoided. Modifications of this idea appear in many of the governors exhibited, the details of construction varying, but the principle remaining unchanged.

An interesting form of auxiliary regulating apparatus of a different principle is found in the Rüsch-Sendtner resistance regulator. This consists of a centrifugal pump, driven by the turbine and delivering water into a chamber from which it takes it again, thus performing little or no work under ordinary conditions. The governor operates a throttle valve in the discharge passage of the pump, thus creating resistance when the wheel tends to run fast and acting as a hydraulic brake to check its speed, this resistance being removed as soon as the speed of the turbine returns to normal. The action is similar to that of the rheostat in electrical regulation.

Girard and Pelton wheels are generally regulated by opening or closing the nozzles, and several ingenious devices are shown by which the contraction of the nozzle is effected without the production of any sudden change of section which might cause excessive friction and eddying, and consequent loss of efficiency. No mention is made of the ingenious method of Cassel for dividing the buckets of the Pelton wheel and causing the two halves to approach or separate, permitting a portion of the jet to pass between the sections. While a close regulation may be secured by varying the opening of the nozzle, this necessarily acts to produce a varying pressure in the pipe line, and serious shocks are apt to occur.

In closing his review, Professor Prásil remarks: "Turbine construction, although of European origin, shows greatly the influence of American ideas, but at the same time the solution of the exact details of form and proportion, as well as of the problems connected with speed regulation, upon fundamental scientific principles, has been mainly effected by European engineers."

Engineering Education.

A GREAT deal has been said of late about the influence of technical and scientific education upon the commercial and industrial development of a nation. Doubtless there has been some exaggerated talk, and also some unwarranted assertions, but anyone who will take the trouble to compare the methods in vogue in that applied science which constitutes engineering at the present day with those followed say, twenty-five years ago, cannot help observing the changes which have been wrought by the entrance of the technically educated engineer into many important fields of work.

Apart from the direct utilitarian value of an engineering education, there is to be considered the so-called "cultural" value, and it is this phase of the question which was discussed in the recent presidential address of Professor E. O. Marvin before the Society for the Promotion of Engineering Education.

Formerly it was supposed that a broad culture could be obtained only by the acquirement of a so-called liberal education; an education which was really far from being really liberal or broad, and was rather confined within decidedly narrow limits of thought and action. Culture is not a thing to be easily defined even where it can be readily identified. To a great extent it is an individual quality, but it is also a quality to be developed by education.

The man of culture must be a thinking and reflecting being, and in engineering training this important faculty can best be obtained by avoiding rush and hurry in the preliminary work. Overcrowding, together with instruction in empirical methods, and short cuts may give a certain degree of facility which is fatal to correct and mature habits of thought.

Very important, too, is the cultivation of the judicial faculty. Honesty of thought is really nowhere so important as in engineering work, and in no branch of work is sham so difficult to conceal. Shiftlessness of thought and action may frequently be glossed over, or covered up in other lines of life, but metal and stone are difficult things to deceive, and the laws of Nature will not be broken; on the contrary, he who tries to break them will in the end find that they will break him. This, then should be the aim of every teacher; to see to it that all standards are based on sound principles of right and wrong, of truth and falsity.

There can be no true culture for a man who does not work.

"A man expresses himself through his work, and whether he will or no he thus discloses to all who know him his own peculiar qualities. It is this intensity of application, this concentration of purpose and directness of aim that gets the world's work done. Here in early years the engineering student has the advantage of the student in arts. Study for knowledge's sake may be stimulating to the few, but for the many there is needed the goal of a special calling to secure the close application that results in ability to concentrate one's energy to the attainment of a certain end." As has been well said already upon the same subject: "It is better to know what to do and how to do it, than merely to know what has been done and who did it."

With special knowledge is also needed a breadth of view, a poise which enables a man to see things in their right relations and due proportions. Possessing such a faculty a man can better understand the motives that underlie other men's actions, and use them to suit his own purpose. He will be more apt rightly to interpret the new movements in the world of thought or action, and can seize opportunity for a personal advantage or a larger sphere of service before others see that there is such.

The importance to the engineer of mathematics and physical science is well understood, but these must not stand in the way

of a broad general training. There are other things to be dealt with besides materials and physical laws, and engineers have also to manage men and matters of finance. "If they are rightly to influence those whose capital they are to expend they must be able to meet them socially and intellectually, to discuss intelligently matters outside of the pale of strictly professional life. Evidence of professional ability and skill is of course first demanded, but breadth of culture creates an added confidence in the wisdom of the conclusions reached and the advice given.

In addition to the ability to form correct judgments must be added the capacity to make a skilful and correct presentation of them in well-chosen and fitting English. This ability cannot be taught by training in the writing of compositions, themes, reports, etc., alone; it must in great part be absorbed by an early and habitual reading of the best that has been written in all lines of thought.

"As one looks forward ten or twenty years and attempts from present tendencies to forecast the work and social standing of engineers, he must see that the profession will be doing a larger work and exerting a greater influence. Further, that an engineering training will be more and more recognized as the one best fitted to lead to positions of an executive nature in connection with industrial enterprises and in the administration of public works. Everywhere will be demanded expert skill, sound judgment and broad views, primarily because these will be found economical."

The Brooklyn Bridge.

THE recent breakage of certain of the suspender rods and bands on the great suspension bridge between New York and Brooklyn has been prolific of numerous articles in the technical and daily press and the details of the subject are given at length in such journals as *Engineering News*, the *Iron Age*, the *Scientific American*, etc.

For a general examination of the subject doubtless the best statement of the occurrence is that of the chief engineer of the bridge, Mr. C. C. Martin, as contained in his report to the Commissioner of Bridges. As is well known, the bridge has four great suspension cables, passing over masonry towers, and provided with deep shore anchorages. The roadway is carried upon a truss system, suspended from the main cables by cables and suspender rods. In reporting upon the breaks, Mr. Martin said:

"Around the cables are placed steel cable bands, which are 5 inches wide and ½ inch thick. These are placed at a horizontal distance of 7½ feet apart. Connected to these, near the center of the main span of the bridge, on each cable, are 2½-inch steel suspension rods; all of the other suspenders on the main span are made of steel wire ropes 1¾ inches in diameter.

"The object of these suspender rods and ropes is to connect the transverse girders of the floor system of the bridge to the cables, which ultimately carry the weight of the bridge with its load.

"On Wednesday afternoon, July 24, it was discovered that seven of these suspension rods and two cable bands were broken, and traffic on the easterly half of the bridge was suspended. On account of the expansion and contraction of the trusses of the bridge there is a longitudinal maximum movement at the slip joints of about 7 inches, and as this movement takes place in the truss, to which the floor beams and the lower ends of the suspender rods are attached, and does not occur in the cable to which the upper ends of these rods are attached, the result is that the lower ends of the rods move backward and forward as the truss expands or contracts.

"In order to provide for this a steel trunnion block was introduced into this connection, which permitted a rolling motion without producing cross strains in the rods. These cast steel trunnion blocks are 5¼ inches deep, the rods passing through them freely, and a nut was placed beneath the block to hold the whole in place. Examination shows that all of the broken rods are broken in these blocks, and entirely out of sight; until enough of them had been broken to allow the cable to lift or the floor to settle sufficiently for the broken ends of the rods to come into sight, nothing would be known of the break.

"An examination of the fracture of two of the rods indicates unmistakably that they have been broken for a long time. All of the remaining suspender rods on this cable and on the other three cables have been

carefully re-examined, and they are in perfect order. As to the broken cable bands, there are 1,700 of them around the cables on the bridge, and it is quite possible, notwithstanding the rigid inspection to which they were subjected before they were put in place, that occasionally a defective band may have been used. Constant inspection since the bridge has been in use has detected a few, and these have been replaced without in any way affecting the strength of the bridge or impeding traffic.

"In my judgment the cause of the present breaking of several of the suspender rods is as follows: As I have said before, two of the broken rods show old breaks—one much older than the other—as indicated by the broken ends of the rods. One rod having broken, would throw additional strains on those adjoining it, and in the course of time these would give way, and the process would naturally continue unless the broken rods were replaced.

"The fact that the rods on all of the other cables are sound would seem to indicate that my theory is correct, and that the fact that one rod—in all respects like all of the others, as far as can be seen—broke long in advance of the others, or that it broke at all would seem to indicate that it was originally defective.

"The bridge is now in perfect working order and is entirely safe."

Accepting this official statement, the whole subject has been discussed from two standpoints—that of placing the true cause of the breaks, and that of providing against its occurrence in the future. So far as the cause of the breaks is concerned, some criticism has been made, and apparently with reason, upon the statement that the material was originally defective in one of the suspender rods. It hardly appears reasonable that nine defective pieces could have been accidentally grouped next to each other, and at precisely the spot where they would be subjected to the most severe duty, although naturally the breaking of one defective rod would throw greater stress upon the adjacent rods. It is hardly good engineering to admit that until enough rods "had been broken to allow the cable to lift or the floor to settle sufficiently for the broken ends of the rods to come into sight, nothing would be known of the break." If breaks cannot be detected until such serious consequences become apparent something surely is wrong, and as has been suggested a tap of a hammer would have revealed to the experienced ear the fact that a suspender rod was no longer under tension.

However much defects in material or in constructive detail may have been responsible for the breaks, there seems to be little doubt that a severe and continual inspection, such as this important structure ought surely to have had from its opening day, would have detected the first of these breaks, and prevented the extension of the accident. The marked reticence of the authorities concerning the methods and severity of inspection is in itself significant on this point.

So far as a prevention of the recurrence of the breaks is concerned, this will probably be made by substituting roller bearings under the suspension points, instead of using the hinged joints. Various methods of introducing such bearings have been suggested and the problem offers no difficulty.

The fact that the bridge has been gradually loaded far beyond the original provision is freely admitted, and as the additional load has been placed gradually in the form of rails, trolley gear, pipes, wires, cables, etc., its magnitude has hardly been realized; it has been estimated at 10 to 15 per cent. in excess of the original load. Since the cables are amply strong this can be provided for by strengthening the road structure, and this, with continual and rigid inspection, should be sufficient to maintain the great bridge in safe condition.

Drawing Room Systems.

VARIOUS papers and discussions have appeared of late concerning systems for the classification and arrangement of drawings of machines and machine parts, but many systems which have been found satisfactory in the shops in which they originated, are found lacking when introduced into other establishments. An interesting paper, treating of the whole subject from a general point of view, by Mr. S. L. G. Knox, appears in a recent issue of the *American Machinist*, from which some abstracts are here made.

In the small shop, where machines are built, rather than manufactured, and where

the drawings are not considered in connection with any machine other than that for which they were originally made, the simplest and cheapest plan is as follows: Make the drawings to as small a scale and on as few sheets as practicable, and put on the drawing sheet and in connection with each particular piece the statement of material, number of pieces wanted, and any special notes as to manufacture.

"This plan permits of a minimum amount of red tape, and makes it unnecessary for draftsmen to be guided by any rules other than a knowledge of mechanical drafting. There will be no cross references, no duplication, in general 100 per cent. of the time devoted to drafting and 0 per cent. to system. The above method of making drawings assumes that but few pieces are to be made alike in the shop from any one piece on the drawing and that the cost of the drawing is therefore an important percentage of the cost of the shop work."

When, however, new machines are to be built in which parts of previous machines are to be used, the above method requires these parts to be drawn over again. In addition to the extra work which this involves, there is also the defect that identical parts are treated independently in the shop, instead of being manufactured, with standard tools, jigs, etc., and so an important method of reducing cost is overlooked. Even when it has been intended to standardize certain parts, it is found that slight changes are permitted during the progress of the design, thereby throwing it out of the class of cheap manufacture. The remedy for this state of affairs is to have standard drawings for pieces which are intended for use on various machines, so that they are at once known to be standards, and not to be changed without special authority. The idea of one piece per sheet is practicable when the output of a shop is in one general line, and where no one except the assembler handles more than one or two pieces of the job, but in any case this method is not the least expensive.

Between the two methods above outlined comes another system, used by Mr. Knox with success in a works employing more than three hundred draftsmen.

"Related pieces are drawn on one sheet, and the full information as to the material of which made, pattern number, piece number, number of parts wanted, etc., is given on the drawing sheet, and while the number of sheets necessary to the manufacture of a given piece of apparatus is thus reduced to a number readily handled and kept track of, all necessity for duplicating the drawings of single pieces is avoided. This scheme is known as the 'Group System' and has certainly been found satisfactory and time saving in the concern referred to, where probably as great a variety of apparatus is manufactured, and over as wide a range of development, from the most highly standardized pieces up to the newest invention still in an experimental state, as can probably be found in any manufacturing concern in the United States."

This system has been extended to a wider scope, since the same group may be used on a number of pieces of apparatus, and a general drawing list made to take the record of information, instead of placing it on the various sheets. This drawing list, or construction specification thus becomes the master record of the system, and from the list the various sheets may be selected, the execution of these producing the required apparatus. When the workman has the drawing put into his hands he has the whole story of the pieces upon which he is working, instead of having to consult two sheets —a drawing and a specification—and is also able to see what pieces go together, thereby being able to use judgment in the degree of accuracy with which the piece is finished.

As to the advantages of the group system over that of the one piece per sheet method, much depends upon the conditions of use, each having its proper and advantageous place.

The important thing to be emphasised is the adoption and maintenance of some system in the making and use of drawings, and of recording their use and location. With this should go a historical record of changes, no change being permitted without having first been made upon the tracing, a record blue print showing the time and nature of the change being made for filing. If the change is too extensive to be made in this manner a new tracing must be made, but this should then take its place as a new drawing, and not as a revision of an old one.

Skeleton Steel Construction.

In a lecture recently delivered before the School of Architecture of the University of Pennsylvania, Mr. W. C. Furber discussed some of the features of skeleton steel building construction, with especial reference to the relation of the work of the engineer and the architect.

The incongruity of retaining forms of external arrangement when the entire principle of construction has been changed, was emphasized. Nearly all the details of architectural ornament have been evolved from the necessities of wood or stone construction, and yet these forms are repeated in terra cotta, tile, and thin veneerings of stone when all reason for their presence has departed.

"The architecture of the iron building of to-day is indefensible because it is first of all a sham, a mere pretense, purporting by its detail to be a masonry structure, yet violating every principle of masonry construction. It is ridiculous, to say the least, to see a building in which the cornices, brackets, and consoles, which are the visible evidence of the bones of the structure, and apparently support the work above them, are wired or strapped to the iron skeleton. The galvanized iron cornice and similar shams are surely no worse."

"The first and most important thing to be done, after the requirements of arrangement have been determined, is to rough out the plan and fill in the main lines of construction; for if this is done it is surprising how easily the rational development of the scheme will follow. It is well in beginning this method, to have more than one approximate plan, and they should not be determined plans. The purposes of the building and the general or specific uses to which it is to be put should have been carefully studied out, and the designer should have fixed in his mind the limitations of the problem, or in other words, he should have found out the things he cannot do. It is wonderful how it clears up the atmosphere to possibilities to discover what the impossibilities are. When you have discovered what you cannot do; the things you can do crowd themselves upon you."

Mr. Furber discusses the question of rust-protection and shows that this feature, so difficult in the case of exposed structures is comparatively simple in connection with buildings in which the structural members can be imbedded in Portland cement, this furnishing an admirable base for any acid which might otherwise produce rust. The metal work should be clean and not painted, although one coat of raw linseed oil may be applied before the members leave the works. Probably the best preparation would be sand-blasting immediately before the imbedding in concrete, this insuring an entire contact of the concrete and the metal. Closed columns should be filled with concrete before being placed in position, notwithstanding the slight delay which this may cause in erection.

"One of the greatest faults of the modern systems of fireproofing is the thinness of the covering. Any non-conducting incombustible covering will prove reasonably efficient if it is thick enough, and thoroughly secured to the columns and girders. The reason the coverings have been made so thin is this: In the transportation from materials of low resistance like stone and brick to materials of high resistance like iron and steel, the difference in the areas required for walls and piers was so great and the space saved so valuable, that the temptation has been to restrict the space occupied by the columns to the minimum. Consequently as little has been allowed for the column and girder coverings as the law allowed, and as a result a good deal of the so-called fireproof covering is insufficient and in many instances improperly applied."

The modern steel building forms a sort of intermediate structure between a bridge and a building of reinforced concrete. The former is all framed work, and usually stands out in bold and usually ugly relief, thankful if it gets its periodical coat of paint. The reinforced concrete structure has its skeleton fully covered with concrete, frequently imbedded in the form of wire netting or rods, and generally in such a form as to be impossible of exterior expression. It is there to stay, and not to be seen or indicated. In such buildings the styles and decoration which obtain with stucco on brickwork construction may be adopted with but slight inconsistency, since the external appearance does not profess to indicate to any great degree the nature of the sup-

porting members within; columns and piers are properly constructed of concrete, with reinforcing rods within and bands about them, and structural forms originally used for masonry construction are not so inappropriate as to be condemned.

When, however, the whole building is a cage, it is almost distressing to the eye to see arches which in the natural order of things would surely force the walls asunder, did we not know that each voussoir was neatly hung upon the deep steel girder behind. The sight of innumerable stories of apparently solid masonry seemingly supported by slender pillars of terra-cotta does not inspire admiration or even respect, although we may feel assured that steel columns of ample strength are somewhere in concealment. It is this sort of thing to which Mr. Furber takes exception, and we join him most heartily in it.

In former times the architect was also the engineer, and his development of architectural styles was the natural outgrowth of the experience of artistic taste in contact with structural conditions. To-day the structural conditions are turned over to the engineer, and the architect, in too many instances, obtains his ideas from structures of other periods and methods. The result is a continual reminder of the story of the man who built his house himself, somewhat after the style of a plain box of magnified dimensions and then sent for a man to come and put some "architecture" on it. Too many of our steel structures have had "architecture" put on them in a fashion that is altogether apparent to every beholder.

The Purification of Water.

At the recent convention of the American Water Works Association, held in New York, there was presented a paper by Mr. P. A. Maignen, which reviews very clearly the progress which has been made in the purification of water for household purposes.

The earlier ideas of the purification of water were well represented by the opinions of Darcy and of Dupuit, and were based mainly upon the process of settling or sedimentation. The separation of earthy matters and other impurities, giving the water time to rest and permit the sediment to gather at the bottom of the basin, appeared to be a very simple matter. It appeared, however, that proper sedimentation required much time and very large reservoirs, and the exposure to warmth sometimes started fermentation. Some fine impurities never settled out, but were apparently disposed to remain in suspension indefinitely.

For these reasons methods of hastening sedimentation artificially were early devised, and of these the use of alum appears to have been known for a long time. Darcy goes on to say that the addition of about 5 grammes of alum per hectolitre of water, or about 2 grains per gallon was sufficient to render muddy water clear in a short time. He also spoke of the advantages of filtration, but apparently his ideas were devoted towards the object of simply rendering the water clear to the eye.

Passing by the processes which are solely chemical, as being necessary only for very hard waters, Mr. Maignen proceeds to examine the subject of water filtration as at present understood and applied in England and America.

The slow sand filter, which has been called "a heap of sand, water poured on top, and extracted from underneath," is, when properly constructed, something much more than a mere strainer. It is improperly used when it is made to receive on its surface the raw water with all its mud, and in order to get the full benefit of the filtration of the sand without the disadvantage of speedy obstruction, it is important that the heavier earthy impurities should be separated, by sedimentation or otherwise. The same is true of the so-called mechanical filter, in which the water is first dosed with a coagulant, such as alum, and then forced through the filter bed under pressure.

Mr. Maignen has devoted much attention to this question of preliminary preparation for filtration, and has devised a form of scrubber containing baffle-plates and straining devices, and finds that in this way a fairly good condition both as regards turbidity and bacterial impurities can be obtained. Such water, in cities provided with a double distribution system, as in Paris, would be plenty good enough for general purposes, etc., and would then be ready for the fuller purification necessary for portable purposes.

In filtering with the slow sand filter, the

true filtering substance is the bacterial membrane (schmutzdecke) which forms on the surface of the sand after a short time, and prevents the passage of further bacterial growths. This membrane is fragile, and care must be taken that it is not disturbed or broken in any way, and when it becomes too thick the water must be drawn off and the surface scraped. Mr. Maignen proposes to deposit upon the surface of the clean sand a thin layer of asbestos fibre by mixing the fibre with the first water which goes on the filter, this forming a coating similar to felt and improving the character and rapidity of the filtration. It is claimed that with this method runs of 120 million to 180 million gallons per acre have been made between cleanings. The cleaning is effected by removing the asbestos layer and the sand is scarcely disturbed.

Regardless of the opinion which may be held as to the substitution of the layer of asbestos fibre for a portion of the thickness of the sand bed, the position as to the preliminary purification of the water before it is delivered to the sand beds is altogether reasonable, and indeed settling basins form, or should form an essential portion of a well designed filtration plant.

The best practice is to design each plant for the location and the water for which it is intended, and any attempt to decide which is the best process or construction is unadvisable before all the conditions are fully known. Water purification is now acknowledged to be a problem demanding the highest degree of skill and judgment of the engineer, and the element of judgment is especially important.

In view of the vast importance of a decision upon which may rest the health and the death rate of a community, too much care cannot be taken to arrive at a correct procedure in each case. The work is above all things of a nature to demand the attention of the highest engineering ability, and when a decision has been reached no degree of supervision and inspection can be too severe, to insure the full and complete execution of the plans which have been adopted.

A word upon the question of the relation of waste to purification may here be given. There appears at the present time in the United States to be an almost insane desire for the supply of an excessive amount of water in cities. This might be intelligible if the water so supplied could be used, or had anything to do with matters of cleanliness or health. As a matter of fact, in many American cities, more than half of the water supplied is wasted, and the magnitude of the supply demanded renders the problem of purification in some instances colossal. The extent to which political influences are interested in maintaining this delusion is in some instances but feebly concealed, and any effort to explain to the more intelligent portion of the community the great advantages of a sufficient supply of pure water, as opposed to an excessive quantity of foul water, is skilfully antagonized.

Ultimately, however, the evil must work its own remedy, and it is possible that the result may be a moderate supply of pure water together with a large supply of raw water, with double distribution; a solution which should be satisfactory both to good citizens and to politicians alike.

New York Subway Construction.

THE construction of the so-called Rapid Transit Tunnel in New York has given rise to some comparisons between the vigor and comprehensiveness of the methods there employed and those used in the construction of the London "tuppeny tube" and the Paris Metropolitain.

In London the conditions were altogether different, and the employment of the shield in boring through the stiff London clay, especially at the depth undertaken was about the only method practicable. In Paris the leisurely progress enabled one portion of the whole system to be completed when the exposition was more than half over, and the remainder will doubtless be continued in the same manner.

In New York the work has been sublet among a number of contractors, and each is using the most effective modern mechanical appliances, and of the eleven separate contracts, eight are being executed by the aid of compressed air plants, the remainder using portable steam power plants. Overhead travellers are used in such open cuttings as permit their use, and power derricks, pumps, and all practicable mechanical appliances are being driven to their utmost

capacity. It is altogether probable that by the time of its completion the tunnel will have set the pace for such work at a rate only comparable with that made by the contractors on the Chicago drainage canal for that class of work, and older methods will be permanently relegated to the domain of the obsolete.

Steam Engines at the Buffalo Exposition.

In nearly all great expositions the steam power plant is one of the most important features, but at the Pan-American Exposition at Buffalo it was at first intended that steam should be made conspicuous by its absence. The power was all to be obtained from the electric current generated by the power of Niagara, and to that end arrangements were made to obtain 5,000 horse power from the Niagara plant, this being assumed to be ample.

Experience showed, however, that this amount would not be sufficient, and hence a steam "service plant" of about 3,600 h. p. was installed as an auxiliary. This service plant, however, was in no sense intended as an exhibit, and it has been made up of such material as could be obtained, and is not fairly a subject for discussion.

In addition to this there is a group of exhibits, consisting of steam engines of a number of well-known makers, and operated by boilers also forming a special exhibit, and from a recent article in *Power* we extract some points about these exhibits.

The boilers by which the steam is furnished call for no especial comment, being of the well-known Morrin Climax type, the principal feature of interest being the firing with natural gas, this enabling all dirt and ashes to be avoided, and permitting the exhibit to be as clean as any other shown.

The engines themselves, while but eleven in number, are fairly typical of excellent modern practice of their size, ranging as they do from 120 to 350 horse power, no example of the large vertical compound engine being shown.

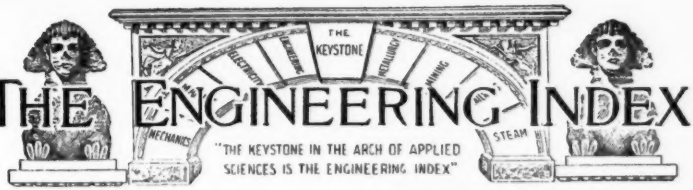
The engines may be divided into two groups, simple and compound, there being six of the former and five of the latter. The simple engines are equally divided between the single-valve and the four-valve types, and the compound engines are two of them four-valve and three single valve.

It is an interesting evidence of the persistence of the influence of the Corliss design that all but one of the four-valve engines are of the Corliss type, differing from each other in minor details only, but the increasing use of the shaft governor of the inertia type appears, eight out of the eleven being thus regulated.

With the exception of one engine, in which the cylinder ratio was 1 to 4, the compound engines adhered to the old ratios of 1 to 2½ or 3, no attempt being made to use the larger ratios which have been so much discussed.

The general details of the various engines are fully given in the article to which reference has been made, and the principal dimensions and data tabulated in convenient form for comparison and to this the interested reader is referred. At the same time some comments may be made upon the distinctive crystallization of American engine building practice which thus appears. Leaving out of consideration the large compound units so generally accepted as the best type for direct-connected electric generators for heavy power stations, we have the single-valve automatic, and the Corliss as the two types. Extreme high-speeds have not persisted, the need for them having departed with the modifications in electric generators. The single-valve automatic, usually self-contained, with crank-shaft between bearings, and overhung cylinder, while not so economical of steam as the four-valve type, is probably as economical of money for moderate sized plants when the total outlay and depreciation charges are considered. For sizes below 100 h. p. it will probably continue to be a staple product of a limited number of establishments.

The four-valve engine, either simple or compound, will doubtless hold its own for larger powers, and the releasing valve-gear shows no signs of abandonment. The one question which has arisen in Europe concerning the Corliss valve or the flat slide valve, that of unsuitability for use with highly superheated steam, will doubtless appear in America when the growing interest in superheating begins to bear practical fruit. The lift valve, balanced and with several seats will then doubtless come into use, and the steam engine may approach more nearly to the gas engine in design.



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Hinged Arch.

Three-Hinged Concrete Arch Highway Bridge Over the Main at Miltenberg, Germany. Abstracted from an article by Eduard Fleischmann, in *Zeitschrift für Bauwesen*. Illustrated description; the hinges are formed of lead strips. 1400 w. Eng News—July 25, 1901. No. 42375.

Iron Bridges.

Curiosities of Early Iron Railway Bridges. Illustrated notes, made by Job Abbott, of peculiar wrought iron bridges in New Brunswick. 900 w. Eng Rec—July 27, 1901. No. 42406.

Mannheim.

The Highway Bridge over the Neckar at Mannheim (Strassenbrücke über den Neckar bei Mannheim). Carl Bernhard. A comparison of the various designs submitted in the competition for the proposed bridge. Serial, Part I. 2000 w. Zeitschr d Ver Deutscher Ing—June 15, 1901. No. 42234 D.

New South Wales.

The Proposed Sydney Harbor Bridge, Sydney, New South Wales. An account of this proposed work and the conditions under which it must be carried out, for which bids are asked by the government of New South Wales. 3800 w. Eng News—July 25, 1901. No. 42373.

The Sydney Harbor Bridge. Editorial discussion of the terms of the second competition for this structure. 1000 w. Eng Rec—July 27, 1901. No. 42401.

North Wales.

Tal y Cafn Bridge. Illustration of a bridge in North Wales, over the river Conway. Description to follow later with additional details. 100 w. Engng—July 12, 1901. No. 42335 A.

Piers.

Construction of the Cambridge Bridge Piers. Describes the methods used in replacing the old pile bridge known as the West Boston Bridge. 1800 w. Eng Rec—July 6, 1901. No. 42032.

The Dunsbach Ferry Bridge. Illustrated description of an unusual method of constructing bridge piers by means of cylinders with piles driven inside and heavy cribwork outside. 900 w. Eng Rec—July 20, 1901. No. 42174.

The Quebec Bridge Piers. Illustrated description of the large caissons and heavy masonry for the cantilever bridge over the St. Lawrence River. 2800 w. Eng Rec—July 27, 1901. No. 42402.

Plate Girder.

The Janesville Bridge. Illustrated description of a railway bridge in Wisconsin, of two 114½-foot spans of plate girders 9½ feet deep and 9 feet apart on centers. 900 w. Eng Rec—July 6, 1901. No. 42031.

Suspension.

A Factory Suspension Bridge. Describes a very light bridge of 250-ft. span, between two buildings. 1100 w. Eng Rec—July 20, 1901. No. 42176.

An Interesting Old Suspension Bridge. Description of a 450-ft. bridge over 50 years old, with cables of straight wires spliced by being flattened, and then wrapped with fine wire. 600 w. Eng Rec—July 13, 1901. No. 42123.

Viaducts.

Des Moines River Viaduct; Chicago & Northwestern Ry. Illustration of this large railway viaduct, with details of the construction and erection taken from a paper by W. C. Armstrong, in the *Iowa Engineer*. 2000 w. Eng News—June 27, 1901. No. 41887.

The Boone Viaduct. Illustrated description of the structural details of a double-track bridge 2,685 ft. long and 185 ft. in maximum height. 2500 w. Eng Rec—July 13, 1901. No. 42122.

The Chicago & Northwestern Viaduct at Boone, Ia. Illustrated description of this viaduct, which is said to be the largest double-tracked structure of its kind in the world. 1700 w. Ry Age—July 5, 1901. No. 42014.

The Mussy Viaduct (Le Viaduc de Mussy). M. Pouthier. A fully illustrated account of this fine masonry railway viaduct in the valley of the Loire, France. 10000 w. 3 plates. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42214 E + F.

CONSTRUCTION.

Building Details.

A Poor Column Seat. Illustrated description of skin work in a New York apartment house. 600 w. Eng Rec—July 27, 1901. No. 42407.

Chimneys.

See Mechanical Engineering, Steam Engineering.

Fire-proof.

Expanded Metal in Fire-Proof Construction. James S. Merritt. Describes briefly the origin of this material and the way it is made, and discusses its use in fire-proof construction. Ill. 2800 w.

Pro Engrs' Club of Phila—July, 1901. No. 42388 D.

Fire-Proof Construction in Philadelphia. Edwin F. Bertolett. Considers the developments of the past and present in the matter of rendering structures invulnerable to fire and flame. Ill. 7500 w. Pro Engrs' Club of Phila—July, 1901. No. 42387 D.

Germany.

The Public Works of Germany (Les Travaux Publics de l'Allemagne). M. de Dartein. A review of the important engineering works in progress and under discussion in Germany as shown by the exhibits at the Paris exposition. 20000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42210 E + F.

Grain Elevators.

Fire-Proof Grain Elevators in America. John Kennedy. A critical comparison of the chief types, with editorial. 3800 w. Eng News—July 18, 1901. No. 42167.

Mill Construction.

A Steel Rolling Mill Building. Illustrated description of a 340 x 133-ft. steel mill building, and a 45 x 70-ft. boiler house. 1000 w. Eng Rec—July 20, 1901. No. 42177.

Reichenberg Baths.

The Emperor Francis Joseph Bath at Reichenberg. Illustrates and describes a public bath of strong construction and well equipped. 1000 w. Eng Rec—July 6, 1901. No. 42036.

Roads.

Earth Roads and Earth Work. Halbert Powers Gillette. Extract from a forthcoming book. Describes the lines along which the cross section should be designed, and discusses other important points in road construction. Ill. 4500 w. Eng News—July 25, 1901. No. 42371.

Road Building in New York State. Information concerning the progress in road construction, the materjal, cost, &c. Ill. 1800 w. Stone—June, 1901. No. 42180 C.

The Interior Main Road, Dominica. An illustrated account of a proposed road, already surveyed, for the improvement of the island and the opening of the interior. 2000 w. Engr, Lond—July 12, 1901. No. 42348 A.

Wear of Roads by Horse Haulage and Motor Traffic. W. Worby Beaumont. Read at Leicester meeting of the Incor. Assn. of Munic. & Co. Engrs. Also discussion. Refers principally to English roads, and considers the greatest wear due to horse's feet. 4500 w. Elec Engr, Lond—July 12, 1901. No. 42307 A.

Steel Structures.

Effects of Splicing and Riveting. George S. Morison. A statement of conclusions drawn from a study of the stresses and strains, with report of mechanical tests, and general discussion. 6600 w. Jour W Soc of Engrs—June, 1901. No. 42145 D.

Structural Details of the Manhattan Railway Power House, New York. Illustrated description of the heavy steel framing in a 100,000-H. P. power station; full details are given of the trusses and columns of the coal pockets. 2800 w. Eng Rec—July 13, 1901. No. 42125.

Stock Exchange.

The New York Stock Exchange. Percy C. Stuart. Briefly reviews the history of the N. Y. Stock Exchange, the buildings occupied, &c., and gives an account of the working out of the design for the new building, the adjustments found necessary, the engineering problems, the facilities for light, ventilation, telephoning, &c. Ill. 9800 w. Archt Rec—July, 1901. No. 42360 C.

Stone Arch.

The Revival of the Stone Arch. Reviews the effect of using iron and steel in building construction, and the causes that are tending to a revival of the stone arch, the principal one being durability. 3000 w. Engr, Lond—June 21, 1901. No. 41928 A.

Subway Construction.

Underpinning the Columbus Monument, New York. Illustrates and describes the method of supporting a 75-ft monument, weighing 724 tons, which is partly on the right of way of the New York Rapid Transit Railway. 1000 w. Eng Rec—July 27, 1901. No. 42204.

Tunnels.

The Collapse of the Pennsylvania Railroad tunnel in Baltimore. Kenneth Allen An account of the accident with discussion of the cause, and description of the work of restoration. 1300 w. Eng News—July 25, 1901. No. 42372.

The Simplon Tunnel. Reviews the progress that has been made, and considers the prospect of a completion within the time limit. 1600 w. Nature—July 4, 1901. No. 42197 A.

The Third Street Concrete and Brick-Lined Tunnel, Los Angeles, Cal. J. H. Quinton. An account of the difficulties met and the methods used in constructing this tunnel. Ill. 5700 w. Eng News—July 18, 1901. No. 42165.

Tunnel Construction on the North Bohemian Transverse Railway (Die Tunnelbauten der Nordböhmischen Transversal bahn). K. Imhof. Details of the excavating, timbering, and construction work on five short tunnels offering constructive difficulties. Three articles. 4000 w. Schweizerische Bauzeitung—June 15, 22, 29, 1901. No. 42263 each B.

CANALS, RIVERS AND HARBORS.

Austria.

Austria's Great Canal System. Outlines a recently adopted measure for a system of canals of great importance. 600 w. U S Cons Repts, No. 1085—July 12, 1901. No. 42077 D.

Canal Resistance.

Tractive Resistance of Canal Boats. Extracts from Mr. Elnathan Sweet's essay in the State Engineer's report on the proposed barge canal from the Hudson to the Great Lakes. 3500 w. Eng Rec—June 29, 1901. No. 41964.

Dams.

The Resistance of Masonry Dams (Résistance des Barrages en Maçonnerie). R. Ruffieux. An elaborate mathematical study of masonry dam construction with diagrams of profiles and pressure curves. 10000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42213 E + F.

Dortmund.

The Dortmund-Ems Canal (Der Dortmund-Ems Kanal). Dr. H. Hoffmann. Especially discussing the harbor improvements at the port of Dortmund, including docks, railway terminals, etc. 3000 w. Zeitschr d Ver Deutscher Ing—July 6, 1901. No. 42239 D.

Dredge.

Petroleum Driven Dredge (Drague à Petrole). M. Wender. Describing a bucket dredge driven by a petroleum motor, and adapted for the requirements of harbour maintenance. 3500 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42215 E + F.

Ellis Island.

The Ellis Island Immigrant Station. Illustrated description of the buildings of this United States immigrant station in New York Harbor. 500 w. Archts & Bldrs Mag—July, 1901. No. 42043 C.

France.

The Utilisation of Canals to Revive our Seaports (Utilisation des Canaux pour le Relievement de nos Ports de Transit). A discussion of the necessity of improving the canals of France to restore the commerce of Marseilles, Havre, etc. Serial. Part I. 1200 w. Revue Technique—June 25, 1901. No. 42231 D.

Harbor Improvements.

The Harbor Works at Tampico, Mexico. Report of a lecture by E. L. Corthell, describing the twin jetties at Tampico and the improvements they have effected. 1400 w. Eng Rec—July 27, 1901. No. 42403.

Lock Gates.

Lock Gates of Wood and of Iron (Portes d'Ecluses en Fer et en Bois). M. Claise. A comparison of the two constructions with regard to repairs and cost considered in view of the magnitude of traffic. 3000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42216 E + F.

Nicaragua.

The Nicaragua Canal Project and its Relation to Commercial and Industrial Prosperity. W. K. Kavanaugh, at the Industrial Convention at Philadelphia. Address urging the building of this canal by the United States. 2800 w. Pro St Louis Ry Club—July 12, 1901. No. 42390.

River Improvement.

An Official Report on the Improvement of the Chicago River. Extracts from the report of Mr. Isham Randolph. 4500 w. Eng News—June 27, 1901. No. 41886.

Improvements of the River Loire. Concerning the proposed deepening of the channel to a depth of 26 feet, and other changes. 800 w. U S Cons Repts, No. 1091—July 19, 1901. No. 42103 D.

The Regulation Works on the Rivers of Northern Germany (Régularisation des Rivières de l'Allemagne der Nord). M. Robert. A study of the river improvement work of northern Germany in view of the proposed regulation of the Loire. 12000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42211 E + F.

The Thames Conservancy. A summary of the general report for the year ending Dec. 31, 1901. 2500 w. Engr, Lond—June 28, 1901. No. 42070 A.

MATERIALS.

Cement.

A New Test for the Fineness of Cement. Describes a new form of testing apparatus, known as the Goreham Flourometer, and the method of testing. 1100 w. Builder—July 20, 1901. No. 42414 A.

Engineering Problems in Cement Manufacture. S. B. Newberry. An account of the development of this industry in the United States, during the last ten or twelve years, with remarks on the nature of hydraulic materials. Ill. Also discussion. 5300 w. Jour W Soc of Engrs—June, 1901. No. 42142 D.

Portland Cements. Gives a comparison of the chemical analysis of a good Portland Cement with two natural cements of the lime and magnesia class, and discusses tests, quality, value, &c. 1200 w. Can Archt—June, 1901. No. 41969 C.

Practical Cement Testing. Gives simple ways of testing that may be used by any engineer, and shows that it is unwise to trust to a cement maker to send good cement. 3500 w. Builder—July 13, 1901. No. 42301 A.

The Cement Industry of the United States. Extracts from Mr. Bill's report concerning the rapid development of the

industry, with reasons why German and Belgian cements are sold more largely than the British product. 2500 w. Arch, Lond—July 19, 1901. No. 42412 A.

The Cement Industry of Western Australia. T. A. Rickard. Outlines the general character of the deposit at Kanowna, and their formation, and gives related matter of interest. Ill. 1700 w. Eng & Min Jour—July 13, 1901. No. 42134.

The Manufacture of Portland Cement in California. Edward Booth. The effect of the discovery of petroleum in California on the industries of the state; the present article dealing with the development of the cement-making material. 1500 w. Sci Am Sup—July 13, 1901. No. 42093.

The Portland Cement Industry in California. G. P. Grimsley. Reviews the attempts made to manufacture portland cement in this state, the causes of failures, and recent plants. Ill. 1200 w. Eng & Min Jour—July 20, 1901. No. 42195.

Fireproofed Wood.

Fire Retardant Treatments of Wood. Abstract of a committee report presented at meeting of the Nat. Fire Pro. Assn. Considers chemically treated wood, and retardant coatings for wood. 2500 w. Eng News—June 27, 1901. No. 41884.

Reinforced Concrete.

A General Study of Structures in Reinforced Concrete (Considerations Générales sur les Ouvrages en Ciment Armé). J. Résal. A discussion of the principles of proportion, showing the method of obtaining the proper relations of elasticity between the metal and concrete. 6000 w. Revue Technique—June 10, 1901. No. 42228 D.

A New System of Reinforced Concrete (Ein Neues System von Armiertern Betou). B. Recordon. Describing a system of built-up construction composed of concrete beams, reinforced with imbedded metal rods. 2 articles. 2000 w. Schweizerische Bauzeitung—June 15, 22, 1901. No. 42264 each B.

Concrete—Steel Bridge and Culvert Construction on the Illinois Central R. R. Illustrations and specifications of interesting structures being carried out in connection with the extensive improvements of this railroad. 9400 w. Eng News—July 18, 1901. No. 42168.

Specifications.

Notes on Specifications for Bridge and Structural Steel. P. S. Hildreth. Notes covering some of the questions which arise in the practical carrying out of specifications. 2500 w. R R Gaz—July 19, 1901. No. 42153.

Structural Steel.

Structural Steel for Bridges, Ships and Buildings. A statement of the changes in the revised standard specifications for structural steel, recommended by a committee of the American Section of the International Assn. for Testing Materials. 600 w. Eng Rec—July 27, 1901. No. 42405.

Wood.

The Preservation of Wood (Conservation des Bois). M. H. Besson. A review of the various processes which have been used for the preservation of timber from decay, with especial reference to the Rutgers process. 7500 w. Men Soc Inglis de France—May, 1901. No. 42217 G.

MEASUREMENT.

Levelling.

A Rapid Method of Levelling. E. Philip Gilman. Short description with sketches. 700 w. B C Min Rec—July, 1901. No. 42109 B.

Surveying.

Hydrographic and Forest Surveys of the United States. Herbert M. Wilson. Explains the work of this division of the U. S. Geological Survey. Map. 2200 w. Eng News—July 11, 1901. No. 42114.

Mine Surveying Problems. W. E. Gordon. An account of methods used under peculiar conditions in the zinc-lead regions of Missouri. Ill. 900 w. Mines & Min—July, 1901. No. 42026 C.

Tape Apparatus.

Tests of the Massachusetts Institute of Technology Tape Apparatus. Alfred E. Burton and John F. Hayford. Gives a brief history of the apparatus, with an account of the tests. 2500 w. Tech Quar—June, 1901. No. 42095 E.

Thermometers.

Thermometer Glass at Higher Temperatures. William McClellan. Describes the construction of thermometers where the boiling point of mercury is raised; and gives an account of the method of testing. 2800 w. Jour Fr Inst. July, 1901. No. 42006 D.

MUNICIPAL.

Cincinnati.

Municipal Notes at Cincinnati. Concerning the bridges, sewers, streets, grade crossings, canals, &c. 2200 w. Eng News—July 11, 1901. No. 42115.

Refuse Destructors.

Refuse Destructors in Combination with Electric Power Stations. J. S. Highfield. Abstract of paper read at the Con. of Munic. Engrs. Assn. at Glasgow, with editorial comment. Considers refuse unsuitable for fuel for the generation of electrical energy. 2500 w. Elec Rev, Lond—July 19, 1901. No. 42418 A.

Roads.

See Civil Engineering. Construction.

Sewage.

Rights as to Sewage. Algernon Barker. A discussion of English law affecting sewage, citing some cases in illustration. 8700 w. Jour Roy Inst of Brit Archts—June 8, 1901. Serial. 1st part. No. 42199 B.

Sewage Disposal.

A New Septic Sewage Disposal Plant. Colin R. Wise. Illustrated description of the construction and operation of the plant at Liberty, N. Y. 2000 w. Munic Engng—July, 1901. No. 42942 C.

Sewage Disposal at Oswestry, England. Information concerning a contact-bed system. 1600 w. Eng Rec—July 6, 1901. No. 42034.

Sewage Purification.

The Bacterial Purification of Sewage (L' Epuration Bactérienne des Eaux d' Egout). G. Richou. A review of British experience in comparison with that employed on the sewage farms of Paris. 2000 w. Génie Civil—June 15, 1901. No. 42201 D.

Notes on Sewage Clarification (Beiträge zur Abwasserklärung). H. C. Nussbaum. An examination of the character of various kinds of sewage, and the purification methods applicable to each. Serial. Part I. 2000 w. Gesundheits-Ingenieur—May 31, 1901. No. 42267 B.

Sewerage.

The Sewerage System of Havana. Illustrates and describes modifications in the plans originally prepared and the introduction of novel features. 2000 w. Eng Rec—July 20, 1901. No. 42172.

Street Lighting.

See Electrical Engineering, Lighting.

Streets.

Comparison Between Asphalt and Brick Streets in Buffalo. Favoring the brick pavement. Ill. 2200 w. Brick—July, 1901. No. 41986.

WATER SUPPLY.

Artesian Wells.

A Few Remarkable Artesian Wells and the Uses to Which They Are Put. Erwin Hinckley Barbour. Illustrated account of the wells of Nebraska and South Dakota. 900 w. Sci Am—July 13, 1901. No. 42090.

Cincinnati, O.

Notes on the Construction of the New Cincinnati Water Works. Describes methods of sinking some large caissons for intake piers, pump wells and tunnel shafts, and gives description of method of constructing two reservoirs of 350,000,000 gallons capacity. 4500 w. Eng Rec—July 13, 1901. No. 42121.

Computations.

Data for Water Computations. An editorial discussion of the inadequate nature of data in several branches of hydrography. 1000 w. Eng Rec—July 20, 1901. No. 42170.

Electrolysis.

See Gas Engineering.

Filtration.

Success of Mechanical Filter at Elmira. James M. Caird. An account of the method and treatment and the gratifying results. 1500 w. Fire & Water—July 20, 1901. No. 42101.

Ground Water.

The Development of Sources of Ground-Water (Ueber die Erschliessung Unterirdischer Quellwässer). A. Tschebull. A study of the investigation of subterranean water sources, and their use for public water supply. 4500 w. Zeitsch d Oesterr Ing u Arch Ver—June 28, 1901. No. 42243 B.

Pollution.

Detecting and Preventing the Pollution of Public Water Supplies. William Watts. Read at meeting of the British Assn. of Water-Works Engrs. The remarks apply exclusively to water from moorland drainage areas. 2700 w. Builder—July 20, 1901. No. 42413 A.

Syphons.

Syphons for Water-Works. Illustrated description by Heinrich Adolf, from the *Zeitschrift d. Oest. Ing. u. Arch. Ver.*, of the principles governing the design and operation of long syphons. 2700 w. Eng Rec—July 27, 1901. No. 42408.

Water Meters.

Some Tests of Very Large Water Meters. Describes the weir used in calibrating 20 and 36-in. meters. 700 w. Eng Rec—July 13, 1901. No. 42124.

Water Rights.

A New Ruling Concerning Underground Water Rights. Review of a decision by which the New York law, making the pumping of underground water from another's land a trespass, is interpreted so as to prevent injustice to the owners of the pumping plant. 1200 w. Eng Rec—July 20, 1901. No. 42171.

MISCELLANY.

Education.

The Cultural Value of Engineering Education. F. O. Marvin. From the presidential address at the annual convention of the Society for the Promotion of Engineering Education. 2000 w. Eng News—July 4, 1901. No. 41994.

New York.

Changes and Improvements in New York. From the *N. Y. Sun*. Concerning the great engineering undertakings in progress, at a cost of many millions. 2500 w. Am Archt—July 6, 1901. No. 42004.

Review.

A Century of Civil Engineering. J. James R. Croes. Presidential address at the convention at Niagara Falls, N. Y., June 25, 1901. 7000 w. Am Soc of Civ Engrs, No. 897—June, 1901. No. 41900 E.

ECONOMICS AND INDUSTRY

Cost Keeping.

The Principles of Cost Accounting. F. A. Halsey. Lecture before the mechanical engineering students of Cornell Univ. Discusses the objects of cost accounting, the principles involved, methods, etc. 7200 w. Am Mach—June 20 and 27, 1901. Serial. 2 parts. No. 42040.

The Proper Distribution of Establishment Charges. A. Hamilton Church. A comparison of the various methods of apportioning expense to work, showing the dependence of the method to the character of the work. 4000 w. Engineering Magazine—Aug., 1901. No. 42293 B.

Education.

To What Extent and in What Direction Is It Desirable for a Professor of Engineering to Accept Engineering Employment. Prof. C. Frank Allen. Read at the Buffalo meeting of the Soc. for the Promotion of Engng. Education. 2700 w. R. R. Gaz—July 19, 1901. No. 42152.

Workshop Training for Young Engineers. R. D. Summerfield. Thinks workshops for technical schools harmful, and that they can never give the training obtained in practical workshops. 1800 w. Elec Engr, Lond—July 19, 1901. No. 42415 A.

Exhibitions.

The Glasgow International Exhibition. General review of the site, buildings, etc., and illustrated account of the exhibits in minerals, iron, steel and engineering, in its various branches. 23600 w. Ir and Coal Trds Rev—June 28, 1901. No. 42075 A.

The Pan-American Exposition. Illustrated notes on the exposition and the engineering exhibits. 8700 w. Mach, N. Y. —July, 1901. No. 41955.

Export Duty.

The Export Duty on Coal. A report of the discussion of the subject in the House of Commons, of the duty of 1s. per ton on coal exported from Great Britain or Ireland. 8000 w. Col Guard—June 28, 1901. No. 42068 A.

Franchises.

The Franchises of Telephone and Telegraph Companies, Legislative, Municipal and Congressional. G. C. Hamilton. From the *American Law Register*. Considers questions bearing on the granting of franchises. 2800 w. Elec Rev, N. Y.—July 20, 1901. No. 42186.

Glasgow Industries.

Notes on Glasgow Industries. Authoritative notes on the principal industries carried on in Glasgow and its neighborhood. Ill. 10700 w. Ir & Coal Trds Rev—June 28, 1901. No. 42076 A.

Gold Supplies.

The Influence of the New Supplies of Gold. George E. Roberts. Discusses the recent enormous increase in production and the problems arising from it. 4000 w. N Am Rev—Aug. 1901. No. 42353 D.

Japan.

Trade and Industry in Japan. Information relating to the engineering industries, their progress and development. 3000 w. Engng—June 21, 1901. No. 41918 A.

Patents.

An Improved Mode of Procedure for the Grant of Letters Patent. G. G. M. Hardingham. Discusses the present system in England and the evils arising from it, proposing a modification. 5500 w. Engng—July 19, 1901. No. 42397 A.

Statistics.

The Home and Foreign Iron and Steel Industries. Concerning the imports and exports of iron, steel and machinery. 4800 w. Ir and Coal Trds Rev—July 12, 1901. No. 42350 A.

Trade Unions.

How Trade Unionism Affects British Industries. Benjamin Taylor. Showing the social and industrial harm due to trade unions: how they restrict output and enhance the cost of production. 7000 w. N Am Rev—Aug., 1901. No. 42352 D.

Trusts.

The German Coal and Iron "Rings." Editorial discussion of the effect of these "syndicates" on trade. 1800 w. Engng—July 19, 1901. No. 42396 A.

Works Management.

A Practical View of Machine Shop Conditions in the United States. M. Cokely. A study of the relations between employer and employee, showing that the true solution of the problem lies in cheap production. 3000 w. Engineering Magazine—Aug., 1901. No. 42289 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable.

The Placing of a New Telephone Cable in the St. Gothard Tunnel (Verlegung eines Neuen Kabels für den Oeffentlichen Femsprech verpelir in Gothard-tunnel). A. Baechtold. With section of the cable and a description of the method of placing. 18000 w. Elektrotech Zeitschr—June 27, 1901. No. 42281 B.

Electrical Waves.

See Electrical Engineering, Electro-Physics.

Flame Telephony.

See Electrical Engineering, Electro-Physics.

Machine Telegraphy.

The Slight Use of Automatic or Machine Telegraphy. Edward A. Calahan. Reviews the telegraphs of this class, discussing the systems, and reasons for their slow adoption, and the effect of the growing use of the telephone. 2000 w. Elec Wld & Engr—July 27, 1901. No. 42432.

Space Telegraphy.

Wireless Telegraphy Up to Date. Fernand Poncelot. An account of experiments between Brussels, Malines and Antwerp (January to March, 1901), especially dealing with the work of M. Guarini, but reviewing the work of others in this field. Ill. 2800 w. Elec Engr, Lond—July 12, 1901. Serial. 1st part. No. 42306 A.

Telegraphy.

The Importance in Telegraphy of Apparently Little Things. Thomas D. Lockwood. Full paper as read before the Assn. of Ry. Tel. Supts. at Buffalo, N. Y. Points in connection with lines, batteries and instruments are discussed. 3700 w. Pro. St. Louis Ry Club—July 12, 1901. No. 42389.

The Mercedier Telegraph. Illustrated description of a multiplex system, based upon the use of rapid oscillatory currents. 1800 w. Engng—June 28, 1901. No. 42057 A.

Telephony.

The Common-Battery Telephone System of the City of New York. Illustrates and describes an exchange equipped with the most perfect apparatus yet devised, and illustrative of the latest improvements. 1800 w. Sci Am—July 13, 1901. No. 42091.

DISTRIBUTION.

Alternating Currents.

Balancing a 3-Wire Alternating Secondary System. L. Denis. This paper was written to open a discussion on the relative merits of the different alternating current secondary systems. 1700 w. Can Elec News—July, 1901. No. 42355.

Aerial Systems.

Notes on the Construction and Protection of Aerial Transmission and Distribution Systems. K. B. Thornton. Read before the Canadian Elec. Assn. Discusses the selection and setting of poles, insulators, wires, etc. 2000 w. Elec Rev, N. Y.—July 6, 1901. No. 42016.

Current Conversion.

Conversion from Constant Alternating Potential to Constant Alternating Current. R. B. Owens. Reviews the methods principally in use, and emphasizes the advantages of a combination of impedance coils and condenser for constant potential—constant current transformation. 1200 w. Can Elec News—July, 1901. No. 42356

The Conversion of Direct into Alternating Current from the Electro-Chemical Standpoint. Showing that certain phenomena in electrolytic work can be explained by the electro-chemist. 1000 w. Elec Rev, Lond—July 19, 1901. No. 42,419 A.

Detector.

A True Ground Detector. T. W. Varley. Illustrated detailed description of the apparatus with methods of using. 2000 w. Elec Wld & Engr—July 13, 1901. No. 42130.

Direct Current.

Changing over. States the advantages of direct current over alternating, and discusses the troubles incidental to changing. 1800 w. Elec Rev, Lond—June 21, 1901. No. 41913 A.

ELECTRO-CHEMISTRY.

Accumulators.

An Alkaline Nickel-Oxide Cell. Prof. Albert L. Marsh. Remarks on experiments made by the writer, considering briefly the different oxides of nickel. 800 w. Elec Wld & Engr—July 27, 1901. No. 42434.

On Mr. Edison's New Accumulator. W. Hibbert. A discussion of some of the facts given by Dr. Kennelly in his description of the cell. 1000 w. Elec Rev, Lond—June 21, 1901. No. 41910 A.

On Theoretical Concentration Changes in the New Edison Battery. E. F. Roeber. Discusses the processes in the new Edison cell from the point of view of theory of the electrolysis of aqueous solutions. 5800 w. Elec Wld & Engr—June 29, 1901. No. 41900.

Notes on the Theory of Accumulators (Beitrag zur Theorie des Akkumulators). Dr. E. Abel. An examination of the theory of the accumulator from a thermodynamic standpoint. 1500 w. Zeitschr f Elektrochemie—June 27, 1901. No. 42,-286 G.

The "Edison" Storage Cell. Briefly describes the cell and discusses its probabilities of satisfying the conditions aimed at by the inventor. 1600 w. Nature—July 4, 1901. No. 42198 A.

The Edison Storage Battery. Re-print in full of the specification of the United States patent, issued July 16. 3000 w. Elec Wld & Engr—July 27, 1901. No. 42,-433.

Alloys.

Electro-Deposition of Alloys. R. A. Lehfeldt. Reviews the methods proposed for the practical preparation of allovs by electrolysis. 2400 w. Elec Chem & Met—June, 1901. No. 41905 A.

Electrochemistry.

Selected Chapters in Electrochemistry. Harry C. Jones. A series of papers on interesting and important matters in electrochemistry, first studying some phenomena on which it is founded. This first chapter considers osmotic pressure. 3300 w. Elec Rev, N. Y.—July 20, 1901. Serial. 1st part. 42184.

Electro-Deposition.

Notes on the Deposition of Copper from Various Electrolytes. A. A. Beadle. Gives results of a series of experiments conducted with the object of seeing what difference of structure copper deposited from various electrolytes under varying conditions showed from that deposited from the sulphate. 600 w. Elec Chem & Met—July, 1901. No. 42411 A.

Iron.

The Electrochemistry of Iron (Ueber die Elektrochemie des Eisens). Dr. R. Abegg. A study of the relations of iron to other metals, considered from an electrochemical viewpoint, suggesting electrochemical methods of analysis for the study of iron. 2500 w. Stahl u Eisen—July 15, 1901. No. 42257 D.

ELECTRO-PHYSICS.

Alternating Currents.

The Induced Alternating Current Discharge Studied with Reference to Its Spectrum and Especially the Ultra-Violet Spectrum. A. W. Wright and E. S. Downs. A study of this discharge when produced on a large scale, with the aim of locating observed lines and discovering their origin. 3000 w. Am Jour of Sci—July 1, 1901. No. 41941 D.

Atoms.

The Divisibility of Atoms. Edwin Edser. Discusses the subject and concludes that there is evidence that particles can be split off from atoms, and can lead an independent existence for a limited time. Electrical experiments are given. 4200 w. Elec Engr, Lond—June 28, 1901. No. 42,-054 A.

Electrical Waves.

Electrical Wave-Transmission. Michael I. Pupin. Gives conclusions derived from experimental investigations, and the application to telephony and telegraphy. 900 w. Tech Quar—June, 1901. No. 42096 E.

Flame Telephony.

Sounding Flames and Flame Telephony (Tönende Flammen und Flammen-telephonie). H. T. Simon. A discussion of the singing arc and its possible applications. 4000 w. Elektrotech Zeitschr—June 20, 1901. No. 42278 B.

Hysteresis.

A Graphical Determination of the Hysteretic Angle of Advance (Graphische Ermittelung des Hysteretischen Voreilwinkels). F. Jacobson. A method by which influence of hysteresis can be simply plotted for any given case. 600 w. Elektrotech Zeitschr—June 27, 1901. No. 42,-280 B.

Magnets.

The Heating of Magnet Coils. S. S. Neu, A. J. Levine, and O. A. Havill. An account of investigations made to determine the distribution of heat under various conditions, relation between rise of temperature and watts per sq. in. of radiating surface, etc. Ill. 2000 w. Elec Wld & Engr—July 13, 1901. No. 42131.

The Influence of the Forms of Pole Upon Magnetic Traction (Ueber den Einflus der Polform Magneten auf die Zugkraft derselben). W. Beneke. A computation of the form of maximum magnetic traction for iron and steel. 2000 w. Elektrotech Zeitschr—July 4, 1901. No. 42284 B.

See also Electrical Engineering, Power Applications.

Resistance.

The Electrical Resistance of the Human Body. W. L. Hooper. From *Tufts Engineer*. An account of experimental investigations. 1100 w. Elec Rev, N. Y.—June 29, 1901. No. 41881.

Standard Cells.

Investigations of Standard Cells (Einige Untersuchungen über Normal Elemente). Dr. H. Rupp. Details of investigations of the Weston, Clark, cadmium, and other standard cells, made in the laboratory of the Technical High School at Stuttgart. Serial. Part 1. 2500 w. Elektrotech Zeitschr—July 4, 1901. No. 42285 B.

Tellurium.

The Thermo-magnetic and Galvano-magnetic Effects in Tellurium. Morton Githens Lloyd. Describes investigations giving qualitative results thus far obtained. 3000 w. Am Jour of Sci—July, 1901. No. 41940 D.

GENERATING STATIONS.

Areuse.

The Power Plants of the Valley of the Areuse (Les Usines de la Vallée de l'Areuse). M. Balling. An account of visits to the various hydro-electric stations on the river Areuse, above Neuchâtel, Switzerland. 10000 w. Ann des Ponts et Chaussées—1 Trimestre, 1901. No. 42,-212 E + F.

Costs.

The Equitable Allocation of Costs in Combined Lighting and Traction Stations. W. H. Tittensor. Read at the Glasgow Congress of the Munic. Elec. Assn. Discusses the cost of generation in a combined station. 3500 w. Elec Engr, Lond—June 28, 1901. No. 42055 A.

Dresden.

The Municipal Electric Plant at Dresden (Das Städtische Elektricitäts-Wesl-Kraftwerk zu Dresden). Walter Meng. A description of the new generating station recently erected in Dresden. Five generating sets of 1200 h. p. each are in use. 4000 w. Elektrotech Zeitschr—June 20, 1901. No. 42276 B.

Dynamos.

Design for a 400-Ampere Electroplating Dynamo. Cecil P. Poole. Illustrated description of the principal features of the machine. 1300 w. Am Electr'n—July, 1901. No. 41974.

The Design and Construction of Polyphase Dynamos (Der Aufbau und die Planmässige Herstellung der Drehstrom Dynamomaschine). O. Lasche. Especially discussing the constructive features of large generators, illustrated by examples of recent large equipments. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 13, 1901. No. 42240 D.

350-Kilowatt Steam Generator at the Glasgow Exhibition. Two-page plate with description. 1100 w. Engng—June 28, 1901. No. 42060 A.

Hagneck.

The Hagneck Electric Station (Das Elektrizitätswerk Hagneck). Dr. H. Rupp. A description of the plant in which more than 6000 h. p. is obtained from the Hagneck drainage canal near the Bielersee, Switzerland. 3500 w. Zeitschr d Ver Deutscher Ing—July 6, 1901. No. 42238 D.

Hydraulic Plant.

The Hydraulic Plant for the Electric Station at Wels, Austria (Wasserkraftanlage für das Elektricitätswerk Wels). R. Janesch. With illustrations of the dam, canal, and turbine house. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—June 21, 1901. No. 42242 B.

Italy.

Great Electric Power Stations of Italy. Enrico Bignami. A fully illustrated account of the great hydro-electric station at Paderno on the Adda; Lombardy. 4000 w. Engineering Magazine—Aug., 1901. No. 42292 B.

Load Factor.

The Influences of the Load Factor on the Design and Operation of a Lighting and Power System. J. R. Robertson. Discusses the means of increasing the load factor without appreciably increasing the investment and fixed charges. 8500 w. Can Elec News—July, 1901. No. 42357.

Rates.

Central Station Tariff System. Arthur Wright. Discusses the system described by Mr. Wallis in his recent paper before the Nat. Elec. Lgt. Convention. 1200 w. Elec Wld & Engr—July 13, 1901. No. 42133.

Short Circuiting.

The Theory of Short Circuited Electric Alternators (Zur Theorie des Kurzgeschlossen Wechselstrom-Generators). F. Horschitz. An analytical and graphical investigation of armature reaction in short-circuited alternators. 2000 w. Elektrotech Zeitschr—July 4, 1901. No. 42282 B.

Storage Batteries.

The Storage Battery in Railway Power Station Service. Lamar Lyndon. Discusses the various applications with a view to furnishing data for determining the sizes of battery and booster necessary to cover requirements under given conditions. 4000 w. St Ry Jour—July 6, 1901. No. 42038 D.

Superintendence.

The Central Station Superintendent. J. H. Vail. A prize article discussing this subject in an able manner. 3000 w. Elec Rev, N. Y.—July 13, 1901. No. 42136.

Transformers.

The Reactance Drop and Reactance Factor of Transformers. A. E. Kennelly. Develops formula and gives table prepared from it, with explanation. 1400 w. Elec Wld & Engr—July 20, 1901. No. 42149.

Vienna.

The Heiligenstadt Power House of the Vienna Municipal Railway (Das Krafthaus der Wiener Stadtbahn in Heiligenstadt). C. Budil. Illustrated description

of this recent plant, with details of the 600 h. p. generating sets. 2500 w. 2 plates. Zeitschr d Ver Deutscher Ing—June 15, 1901. No. 42233 D.

LIGHTING.

Exposition Lighting.

Ground Lighting at the Pan-American and Prior Expositions. Luther Stieringer. Illustrated review of the writer's work, discussing the difficulties and defects. 2500 w. Elec Wld & Engr—July 20, 1901. No. 42148.

Incandescence.

Incandescent Lamp Economy. Abstract of a paper by Guy V. Williams, read at the Sheboygan Convention of the Northwestern Elec. Assn. on the importance of each company possessing a lamp-testing outfit and the value of the photometer when properly used. 1800 w. Elec Wld & Engr—July 6, 1901. No. 42086.

Municipal Plant.

Luton Electricity Works. Illustrated description and brief history of this municipally owned electric lighting plant in England. 1600 w. Elec Engr, Lond—July 12, 1901. No. 42305 A.

Street Lighting.

Street Electric Lighting. Bailie W. Maclay. Read before the Incor. Munic. Elec. Assn. Also discussion on the superiority of electric lighting for this purpose. 3300 w. Lightning—July 4, 1901. No. 42308 A.

Street Lighting. Discusses briefly the principal methods of arc lighting. 1800 w. Elec Rev, Lond—June 21, 1901. No. 41,914 A.

Therapeutics.

The Treatment of Lupus by the Arc Light. An illustrated article explaining treatment which has met with marked success. 2300 w. Elec Rev, Lond—July 12, 1901. No. 42316 A.

MEASUREMENTS.

Galvanometer.

Investigations on the d' Arsonval Galvanometer (Untersuchungen über d'Arsonval-Galvanometer). G. Kümmell. A comparison of galvanometers of various makers, showing methods of calibration. 1800 w. Zeitschr f Elektrochemie—July 4. 1901. No. 42287 G.

Meters.

Notes on Meter Testing. Arthur T. Smith. A few notes on the testing of an integrating wattmeter. 800 w. Elec Rev, Lond—June 21, 1901. No. 41911 A.

Power Measurement.

Power Measurement in the Case of Polyphase Circuits. J. A. Fleming. From a forthcoming book. Describes the methods of estimating in various cases giving a graphical method of solution accurate enough for practical purposes. 1700 w. Electr'n, Lond—July 5, 1901. No. 42313 A.

Motor Power Calculations. J. Boisselot. Gives rules for calculating the approximate horse power of gasoline motors. 500 w. Horseless Age—July 10, 1901. No. 42,079.

Pyrometers.

Electric Pyrometers. W. Rosenhain. Discusses the subject of the accurate measurement of high temperatures, and gives an illustrated description of some of the Griffith-Callendar instruments. 2,500 w. Elec-Chem & Met—June, 1901. Serial. 1st part. No. 41906 A.

Recording Apparatus.

An Apparatus for Recording Alternating-Current Waves. Frank A. Laws. Illustrated description of an apparatus constructed at the Rogers' Laboratory; a modification of the "contact method," by which the record is rendered continuous and traced photographically. 800 w. Tech Quar—June, 1901. No. 42097 E.

Standards.

Dominion Electrical Standards. O. Higman. Describes the apparatus procured as standards of electrical measure. 4500 w. Can Elec News—July, 1901. No. 42354.

Standards for the Testing of Electric Machinery (Normalien zur Prüfung von Elektrischen Maschinen). The full text of the proposed code to be acted upon by the German Electrotechnical Society. 4000 w. Elektrotech Zeitschr—June 13, 1901. No. 42274 B.

Explanations of the Standards for Testing Electrical Machinery (Erläüterungen Zuden Normalien zur Prüfung von Elektrischen Maschinen). G. Dettmar. Very full explanatory comments on the proposed standards of the German Electrotechnical Society. 9000 w. Elektrotech Zeitschr—June 20, 1901. No. 42277 B.

Voltameter.

A New Solution for the Copper Voltameter. William K. Shepard. Gives a solution used by the writer, and the good results obtained. 2100 w. Am Jour of Sci—July, 1901. No. 41939 D.

POWER APPLICATIONS.

Building Equipment.

A Study in Electro-Hydraulics. Frank A. Pattison. On the application of the electric motor to pumping, elevator service, fire-fighting in high buildings, etc. Ill. 2200 w. Eng News—July 4, 1901. No. 41991.

Elevators.

Test of Sprague-Pratt Elevators in the Park Row Building, New York. Gives the results of test made, and the general con-

ditions. 2000 w. Eng Rec—July 6, 1901. No. 42033.

Factory Plant.

Power Plant in the Factory of John Mehl, Jersey City. An illustrated description of a carefully planned small plant. 1400 w. Engr, U. S. A.—July 1, 1901. No. 41987.

The New Power Plant of the Joseph Dixon Crucible Company. Illustrated description of a plant for electrically operating machinery in a number of buildings. 1300 w. Eng Rec—July 20, 1901. No. 42175.

Hoists.

Electric Hoists on the Comstock. Leon M. Hall. Describes the system installed at this mining plant. A continuous rope electric hoist, driven by means of a variable speed, three phase induction motor. 1200 w. Sci Am—July 27, 1901. No 42.-367.

Magnets.

Electro-Magnets for Heavy Lifting. George E. Walsh. On their use and economy in shops, their design, present stage of development, etc. 1800 w. Elec Rev, N. Y.—July 13, 1901. No. 42137.

Motor Efficiency.

The Efficiency Curve of a Shunt Motor and Its Relation to Operating Characteristics and the Cost of Operation. Summary of a paper by Prof. Budd Fronkenfeld, at the Sheboygan convention of the Northwestern Elec. Assn. An outline of the method of testing for efficiency. 3300 w. Elec. Wld & Engr—July 6, 1901. No. 42085.

Motors.

Use and Care of Motors. Lloyd Marshall. Some points bearing on the service and control of motors and the care needed. 1800 w. Engr, U. S. A.—July 1, 1901. No. 41988.

Newspaper Plant.

The Electrical Plant of a Philadelphia Newspaper. J. H. Vail. Illustrated detailed description of the plant of the *North American*, the oldest newspaper in America. 3000 w. Elec Wld & Engr—July 27, 1901. No. 42431.

Paper Making.

Paper Making by Electricity at Willinocket, Maine. Alton D. Adams. Illustrated description of the electric plant of the Great Northern Paper Company. 3500 w. Elec Wld & Engr—June 29, 1901. No. 41898

Polyphase Motors.

The Measurement of Energy in Polyphase Motors (Ueber Energiemessung an Drehstrommotoren). Dr. G. Stern. A discussion of the methods employed in the testing rooms of the Union Electric Company at Berlin. 3500 w. Elektrotech Zeitschr—July 4, 1901. No. 42283 B.

Power Measurement.

See Electrical Engineering, Measurement.

Power Transmission.

The Transmission of Power by Electricity (Le Transport de la Force par l'Electricité). A review of the development of the electrical transmission of power, with especial relation to the requirements in case of the introduction of electric driving on main line railways. 2000 w. Revue Technique—June 25, 1901. No. 42232 D.

Pumping.

Electrically Driven Pumping Machinery (Elektrisch Betriebene Wasserhaltungen). H. Hoffman. Especially discussing the application of electric driving to underground pumping machinery. 2500 w. Zeitschr d Ver Deutscher Ing—June 29, 1901. No. 42237 D.

The Bergmans Pump (Die Bergmanspumpe). R. Goetze. Description of an improved form of mining plunger pump, especially adapted for electric driving. 1200 w. Glückauf—July 6, 1901. No. 42270 B.

The Bergmans Electric Mine Pump. R. Goetze, in *Glückauf*. Illustrated description of a pump growing in favor in Germany. 1200 w. Col Guard—July 12, 1901. No. 42334 A.

TRANSMISSION.

Long Distance.

Western Practice in Long Distance Transmission. Begins a general review of western practice and a comparison of methods in different plants. Also editorial. 3800 w. Elec Wld & Engr—July 13, 1901. Serial. 1st part. No. 42132.

Long Span.

The Great Carquinez Transmission Span. An illustrated description of this engineering achievement at Carquinez, in California, and its construction. 4000 w. Jour of Elec—May, 1901. No. 41882.

Overhead Construction.

Notes on the Construction and Protection of Aerial Transmission and Distribution Systems. K. B. Thornton. Discusses the essential features of good construction. Ill. 4000 w. Can Elec News—July, 1901. No. 42358.

Three Phase.

Missouri River Power Company's 50,-000 Volt Transmission Plant. Illustrates and describes a 70-mile three-phase line being built in the Rocky Mountain district from Canon Ferry to Butte, Montana. 500

w. Elec Wld & Engr—July 13, 1901. No. 42129.

MISCELLANY.

Depreciation.

Depreciation of Lighting and Telephone Plants. Abstract of a paper by George Wilkinson touching many points of interest relating to the wear and tear upon plant, putting the depreciation at about 10 per cent per annum. 1600 w. Elec Wld & Engr—July 27, 1901. No. 42435.

Exposition.

Electric Machinery at the Glasgow Exhibition. Illustrates and describes interesting exhibits. 1400 w. Engr. Lond—July 12, 1901. Serial. 1st part. No. 42342 A.

Germany.

Direct Current Engineering Practice in Germany. Charles Brandeis. An illustrated description of German engineering practice and methods. 1200 w. Elec Wld & Engr—July 6, 1901. No. 42083.

GAS ENGINEERING

Accounts.

Prepayment Meter Accounts and Records. Ernest William Bell. Gives a method which has proved successful in a department operating over 5000 meters. Discussion. 3200 w. Pro Age—July 1, 1901. No. 41961.

Acetylene.

Acetylene Stoves and Their Application. A. J. Murdock. Description of a heating burner for use with acetylene gas. 1500 w. Met Work—July 6, 1901. No. 41985.

Results of Practical Experiments with High-Pressure Acetylene Lighting. Harvey T. Hauer. Read before the International Acetylene Assn., at Buffalo. On the properties and the success in lighting railway coaches, harbor and buoy lighting, and other uses, giving interesting tests made. 4000 w. Pro Age—July 15, 1901. No. 42141.

Simple Generation of Acetylene and Its Purity. Describes the Husson plant. 1500 w. Jour Gas Lgt—July 2, 1901. No. 42,-106 A.

The First Acetylene Gas Works in the Netherlands (De Eerste Acetyleen-centrale in Nederland). J. A. De La Porte. Illustrated description of the plant recently erected near Duurstede, Holland. 1500 w. De Ingenieur—June 15, 1901. No. 42245 D.

The Future of Acetylene Lighting. George Landis Wilson. A copyrighted paper read before the meeting of the International Acetylene Assn., at Buffalo, N. Y. Discusses its advantages, uses and the outlook. 3800 w. Met Work—June 29, 1901. No. 41876.

Comparisons.

Comparison of Different Heating and Lighting Gases. Abstract of article, by Joh. Korting, published in the *Jour. für Gasbeleuchtung*, giving comparison and conclusions. 2700 w. Gas Wld—July 6, 1901. No. 42304 A.

Electrolysis.

The Question of Electrolysis. The evidence and discussion before the Select Committee of the House of Commons. 6400 w. Gas Wld—June 29, 1901. No. 42053 A.

Enrichment.

Enrichment of Gas by Benzol. M. A. Lecomte. Describes the apparatus of the Societe des Huiles Minerals de Colombes, giving comparisons of cannel and benzol and other information of interest. Ill. 3200 w. Gas Wld—July 20, 1901. No. 42421 A.

Heating Power and Welsbach Value of Enriched Gas. M. Verdier. Data from tests made; the heating values were ascertained with Mahler's bomb and Junkers' calorimeter, which gave concordant results. 1400 w. Gas Wld—July 20, 1901. No. 42422 A.

On the Automatic Carburation of Gas by Benzol. M. Laeaze. Brief illustrated description of method of automatically supplying the amount of benzol needed. 500 w. Gas Wld—July 20, 1901. No. 42423 A.

Fittings.

Gas and Gas Fittings. This introductory article reviews briefly the history of the gas industry. 2100 w. Builder—July 6, 1901. Serial. 1st part. No. 42300 A.

Gasholders.

A Large Gasholder for Newcastle. Detailed description and drawings. 2400 w. Jour Gas Lgt—July 2, 1901. Serial. 1st part. No. 42107 A.

Lighthouses.

Gas for Lighthouses. Editorial review of a book by Thomas Williams, on "The Life of Sir Thomas Nicholas Douglass, giving additional facts in regard to the trials of gas as an illuminan. 4000 w. Jour Gas Lgt—July 9, 1901. No. 42309 A.

Power Gas.

Power-Gas Driving with Alpine Lignite (Kraftgasbetrieb mit Alpiner Braunkohle). F. Zeyringer. Giving analyses of the Leoben, Köflach, and Fohnsdorf lignites, showing their suitability for making producer gas for gas engines. 2000 w.

Stahl u Eisen—June 15, 1901. No. 42,-253 D.

The Direct Utilisation of Blast Furnace Gas (Utilisation les Gaz des Hauts Fourneaux). A Dutreux. A very full review of the progress which has been made in the direct use of waste furnace gases in internal combustion motors. From articles. 7500 w. Géne Civil—June 22, 29, July 6, 13, 1901. No. 42203 each D.

The Purification of Blast-Furnace Gases (Die Reinigung der Hochofengase). F. W. Lürmann. A response to comments upon the author's recent paper on the same subject, with additional data as to the preparation of furnace gases for use in internal-combustion motors. 1800 w. Stahl u Eisen—June 15, 1901. No. 42252 D.

The Purification of Blast Furnace Gases (L'Epuration des Gaz de Haut-Fourneau). Jules Deschamps. An examination of the impurities found in blast furnace gases, and a discussion of the methods for preparing the gas for use in internal combustion motors. Serial. Part I. 5000 w. Revue de Mécanique—June 30, 1901. No. 42220 E + F.

Utilization of Blast-Furnace Gases for the Production of Power. Summary of a paper by Herr Lürmann read at a meeting of the German Iron Works Assn., and published in *Stahl und Eisen*. Considers the purification, utilization, and appliances. 7200 w. Engr, Lond—July 5 and 12, 1901. 2 parts. No. 42328 each A.

Purification.

Purification and Method of Working Purifiers. B. W. Smith. Discusses the merits of various methods. 4000 w. Gas Engs' Mag—June 10, 1901. No. 41895 A.

Pyrogas.

Production of Lighting Gas from Smoke. A description of the process of Tobiansky d' Altoff, by which smoke and chimney gases are carburetted, and the product used for heating and lighting. 1400 w. Jour Gas Lgt—July 9, 1901. No. 42310 A.

Rates.

Differential Rates for Gas. Herr von Oechelhaeuser. Read at Vienna meeting of the German Assn. of Gas and Water Engrs. The writer's views based on extensive experience and observation, with discussion of the conditions and reasons. Diagrams. 3300 w. Jour Gas Lgt—July 16, 1901. Serial. 1st part. No. 42312 A.

Siphon.

Submerged Inverted Siphon of the Massachusetts Pipe Line Gas Co., at Everett, Mass. W. W. Cummings. Illustrates and describes this siphon, whose characteristics were its economy and rigidity for a rather unusual length. 600 w. Eng News—July 18, 1901. No. 42160.

MARINE AND NAVAL ENGINEERING

Auxiliaries.

Mercantile Auxiliaries. Lord Brassey. Read before the Inst. of Naval Archts. Reviews the history of the question and discusses the steps practicable in furtherance of a more vigorous policy. 3500 w. Engng—June 28, 1901. No. 42063 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkhead Doors.

Hydraulically-Operated Bulkhead Doors. Illustrations and explanations of method of operating the mechanism. 600 w. Engng—July 12, 1901. No. 42337 A.

Coast Defense.

Submarine Mines. Illustrated description of this means of coast defense. 1300 w. Sci Am Sup—July 27, 1901. No. 42,-370.

Cost.

The Cost of Ships. Theodore Lucas. Discusses points affecting the first cost of ships. 1400 w. Naut Gaz—July 11, 1901. No. 42135.

Cruiser.

H. M. Cruiser Leviathan. Illustration and brief description. 1000 w. Engr, Lond—July 12, 1901. No. 42347 A.

Draftsmen.

Rules Governing the Employment of Draftsmen by the U. S. Navy Department. Nearly a full reprint of the recently issued order. 4500 w. Eng News—July 11, 1901. No. 42113.

Floating Dock.

Floating Dock for the Spanish Government. Illustrates and describes the largest dock afloat, just completed. It is a self-docking, pontoon dock, to be located at Port Mahon, Minorca, but was formerly intended for the Philippines. 1400 w. Engr, Lond—July 5, 1901. No. 42332 A.

Freeboard.

On Freeboard. Archibald Denny. Read before the Inst. of Naval Archts. Short historical paper placing on record important facts in connection with the work with the Load Line Regulations. 1700 w. Engng—July 5, 1901. No. 42326 A.

Gunboat.

The Shallow-Draught Gunboat "Teal." Illustration, description and report of trials of this British vessel. 900 w. Engng—June 28, 1901. No. 42061 A.

Marine Engineers.

National Prospects on the Sea and the Young Marine Engineer. George W. Melville. Briefly reviews national conditions, and the American merchant marine, calling attention to the opportunities awaiting young marine engineers. 4500 w. Stevens Ind—July, 1901. No. 42428 D.

Repairs.

Conversions and Rearmament of Ships on the Effective List. Lord Brassey. Read before the Inst. of Naval Archts. Urges the re-enforcing the navy by making improvements in seaworthy ships. 1800 w. Engng—June 28, 1901. No. 42064 A.

Speed.

On the Limits of Economical Speed of Ships. E. Tennyson-D'Eyncourt. Read before the Inst. of Naval Archts. Presents some practical rules based on facts obtained from a large number of trials of ships of different forms, and a general study of the subject. 2400 w. Engng—June 28, 1901. No. 42065 A.

Steamboats.

New York Steamboats of 1851. An account of the early steamboats of the Hudson River and Long Island Sound, with reprints of articles published in the papers of that time. 3500 w. Naut Gaz—July 18 and 25, 1901. Serial. 2 parts. No. 42150.

Steamships.

The Screw Steamer "Cape Verde" (Der Schraubendamnfer "Cap Verde"). Illustrated description of a fine new steamer engaged in the Hamburg-South American trade, and built at Flensburg. 3000 w. 2 plates. Zeitschr d Ver Deutscher Ing—June 29, 1901. No. 42236 D.

Strength.

The Transverse Strength of Ships. J. Bruhn. Read before the Inst. of Naval Archts. Discusses methods of estimating, considering frames, floors, deck beams, stringers, bulkheads and wide-spaced beams. 8500 w. Engng—July 5, 1901. No. 42327 A.

Torpedo-Boat.

Oil Burning Torpedo-Boat. Illustrated description of the "Pangrang," one of three vessels recently built for the Dutch Government, the notable feature is that the boilers are fitted with a supplementary oil-burning apparatus. 1000 w. Engng—June 21, 1901. No. 41923 A.

Turbine Steamer.

The "King Edward." Illustration with description of the latest Clyde passenger steamer; built for the purpose of trying the working of the Parsons' steam-turbine machinery for mercantile purposes. 1300 w. Engng—July 5, 1901. No. 42324 A.

Turbine Steamer King Edward a Success. Illustration and general information. 1200 w. Marine Rev—July 18, 1901. No. 42187.

Vibration.

A Solution of the Vibration Problem. J. H. Macalpine. Read before the Inst. of Naval Archts. Describes a special form of balanced engine, giving reasons why the author claims that it is a practical solution of the balancing problem for steamships. 4200 w. Engng—July 12, 1901. Serial. 1st part. No. 42339 A.

Warships.

Progress of Warships and Machinery Building in England. Résume of progress during the past half-year with the work for British and foreign navies. 2500 w. Engr, Lond—June 28, 1901. No. 42074 A.

Yachts.

The America Cup Race. Editorial discussion of the racing yachts to compete. 2000 w. Engr, Lond—July 12, 1901. No. 42344 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Alcohol.

The Use of Alcohol in Motors for Automobiles (L'Emploi de l' Alcool daus les Moteurs d' Automobiles). A tabulated review of the performance of 30 different kinds of vehicles using alcohol in internal combustion motors. 2500 w. Génie Civil—June 29, 1901. No. 42206 D.

European Automobiles.

Automobiles in Europe. Information relating to the roads, recent machines, accidents, associations, and special press. 2400 w. U S Cons Repts, No. 1095—July 24, 1901. No. 42164 D.

Gasoline.

Average American Gasoline Vehicle Practice. Albert L. Clough. Information collected by the author from an examination of twelve vehicles. 1700 w. Horseless Age—July 17, 1901. No. 42159.

The New Riker Gasoline Carriage. Illustrates and describes a recently completed vehicle of the French type, with tonneau body and motor placed under a steel bonnet at the front. 2000 w. Horseless Age—July 3, 1901. No. 41984.

Liverpool Trials.

Liverpool Self-Propelled Traffic Association Third Trials of Motor Vehicles for Heavy Traffic. Descriptions and illustrations of the competing vehicles with report of trials. 13700 w. Auto Jour—June, 1901. No. 41896 A.

The Liverpool Trials. Henri G. Chatain. Describes the conditions under which these trials are held, the purposes for which the vehicles are supposed to be used, their constructive details and performance. 1500 w. Horseless Age—July 10, 1901. Serial. 1st part. No. 42078.

Military Automobile.

Marconi's Wireless Telegraphy Automobile for Military Purposes. Illustrates and describes a portable installation specially adapted to military requirements. 800 w. Sci Am—July 20, 1901. No. 42158.

Motor Cars.

Electric Motor Cars and Tests. Rankin Kennedy. Considers the tests usually made of little value, and suggests methods of testing the battery. 1200 w. Elec Rev, Lond—July 19, 1901. No. 42420 A.

Motor Trials.

Glasgow International Exhibition 500-Miles Trials. An account of the trials to take place from Sept. 2 to 6, the rules, regulations, &c. 6000 w. Auto Jour—July, 1901. No. 42361 A.

Mountain Tour.

The Passage of the St. Gothard in an Automobile. (Le Passage du Saint-Gothard en Voiturette Automobile). I. Arraou. An account of a trip of nearly 2000 miles from France to Italy and return, in a de Dion-Bouton carriage. 2000 w. Génie Civil—June 15, 1901. No. 42202 D.

Mowing Machine.

Moto-Driven Mowing Machine. Illustrated description of a design built in Chicago. 700 w. Engng—June 21, 1901. No. 41921 A.

Oil Engines.

Agricultural Oil Engines and Automobilism. A brief study of data published in regard to these engines, exhibited at the Cardiff Exhibition. 1600 w. Auto Jour—July, 1901. No. 42363 A.

Light Oil-Motor Cars. C. C. Longridge. A series of articles intended for owners and users of pleasure vehicles who have had little acquaintance with the subject before purchasing a motor car. The present article considers slow combustion oil motors and explosion motors. 1800 w. Engr, Lond—July 5, 1901. Serial. 1st part. No. 42329 A.

Paris-Berlin.

Paris-Berlin Motor Car Race. Illustrations of some of the vehicles which took part. 200 w. Engr, Lond—July 12, 1901. No. 42345 A.

Paris-Berlin Race. An account of this very successful race, with the official time of the racing vehicles. 3500 w. Auto Jour—July, 1901. No. 42362 A.

The Great Race from Paris to Berlin. Full illustrated account of this interesting race of over 744 miles. 13000 w. Auto Car. Serial. 2 parts. July 6, 13, 1901. No. 42302 each A.

The Paris-Berlin Motor Car Race. Remarks on the useful purpose served by racing, and on the performance of the vehicles in this race. 2700 w. Engr, Lond—July 19, 1901. No. 42391 A.

Paris-Bordeaux.

The Gordon-Bennett Cup and Paris-Bordeaux. An account of these events which were practically merged into one race. 2500 w. Auto Jour—June, 1901. No. 41897 A.

Voiturette.

The 6 H. P. Argyll Voiturette. Illustrated description of the construction and drive. 1500 w. Autocar—June 22, 1901. No. 41907 A.

Wheels and Tires.

Wheels and Tires for Motor Trucks. Walter L. Bodman. Discusses the problem of economical maintenance and the obtaining of ample adhesion on all kinds of roads in all kinds of weather, giving results of experiments. 2500 w. Horseless Age—July 24, 1901. No. 42359.

HYDRAULICS.

Hydraulic Plant.

See Electrical Engineering, Generating Stations.

Lift Wheel.

The Water Lift Wheels at the Maas Improvement Works (Die Schaufelräder an der Neuen Maasmündung). A description of the water lift wheels driven by compound steam engines, and used in the drainage works at the mouth of the Maas; with data of performance. 1800 w. Glaser's Annalen—July 15, 1901. No. 42262 D.

Plumbing.

Plumbing in the Prudential Buildings, Newark, N. J. Illustrated detailed description of the plumbing for four large twelve-story buildings occupying adjacent corners. 2700 w. Eng Rec—July 6, 1901. No. 42035.

Pumping.

See Electrical Engineering, Power Applications.

Tools.

Hydraulic Power in Steel-Making. R. M. Daelen. Read before the Iron and Steel Inst. Discusses the growing use of

high pressures and the means of obtaining them. Ill. 2400 w. Engng—June 28, 1901. No. 42062 A.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings (Kugellager). Dr. Stribeck. A study of ball bearings with especial reference to the pressure upon the balls and the reduction of friction in various constructions. 4000 w. Glaser's Ann—July 1, 1901. No. 42259 D.

Castings.

Casting a Housing for a Saw Mill. R. H. Palmer. Illustrates casting and explains method of casting. 900 w. Am Mach—July 18, 1901. No. 42162.

Thickness of Plates Encastré. George E. Barrett. Formulas for calculating the thickness of flat cast plates, such as steam chest and cylinder covers. 700 w. Am Mach—July 25, 1901. No. 42365.

Cost Keeping.

See Economics and Industry.

Crown Bolts.

A Chapter on Crown Bolts. D. P. Kellogg. Illustrated descriptions of some of the many forms of these bolts. 800 w. Loc Engng—July, 1901. No. 41944 C.

Dies.

An Improved Blanking and Piercing Die, and Two Bending Dies. William Doran. Illustrations showing how a rather intricate job in blanking, piercing and bending sheet metal may be accomplished by the use of dies which are simple and inexpensive to construct. 1800 w. Am Mach—June 27, 1901. No. 41889.

Punching and Forming Heavy Blanks in One Operation. William Doran. Illustrates and describes a die for producing blanks from heavy sheet metal, blanking and bending them to the shape required in one operation. 1200 w. Am Mach—July 11, 1901. No. 42081.

Drawing Office.

An Outline of the Drawing Office System of the General Electric Company. S. L. G. Knox. Describes a system found satisfactory in a concern employing over three hundred draftsmen and having a total of over twelve thousand men. Ill. 3000 w. Am Mach—July 25, 1901. No. 42364.

Gears.

Table of Formulas for Bevel Gears. Edward T. Elbourne. Formulas and notes. 450 w. Am Mach—July 18, 1901. No. 42161.

Indexing.

A New Method of Compound Indexing on the Universal Milling Machine. John T. Giddings. Describes a method much shorter and more saving of labor than the one in common use. 1000 w Mach, N. Y.—July, 1901. No. 41958.

Jigs.

A Jig for Accurately Drilling a Plate. Joseph V. Woodworth. Illustrated description. 400 w. Am Mach—July 18, 1901. No. 42163.

Two Drill Jigs for Odd Shaped Castings. William Doran. Illustrated description of the design and construction. 1000 w. Am Mach—July 4, 1901. No. 41979.

Machine Tools.

British Machine Tools at the Glasgow Exhibition. Illustrations and descriptions of the exhibits. 16800 w. Engr, Lond—June 28, 1901. No. 42073 A.

Measuring.

The Interferometer. H. G. Gale. Illustrated explanation of the principle of this instrument and the method of measuring very small distances and angles in terms of the wave length of light. 4000 w. Am Mach—July 11 and 18, 1901. Serial. 2 parts. No. 42080.

Patterns.

Insuring Patterns. Frederick Conlin. The object of the paper is to bring before the Am. Found. Assn. the advisability of adopting rules governing questions of insurance. 3500 w. Jour Am Found Assn —June, 1901. No. 42160.

Repetition Work.

Repetitive Shop Processes and Interchangeable Machine Parts. Barton Cruikshank. A discussion of the fundamental rules governing successful repetition work, with examples in illustrations. 3000 w. Engineering Magazine—Aug. 1901. No. 42295 B.

Screw Machine.

The Sittman Screw Machine. Illustrated detailed description of a machine embodying new and valuable features. 3800 w. Ir Age—July 11, 1901. No. 42082.

Shops.

Shops of John Long & Sons, Johnstone, Scotland. Illustrates and describes this machine-tool building establishment of Scotland. 900 w. Am Mach—July 4, 1901. No. 41976.

The Sharon Steel Company. An illustrated detailed description of extensive works. 6500 w. Ir Age—July 4, 1901. No. 41962.

Works of G. & J. Weir, Limited, Glasgow. Illustrated description of shops where modern methods are used in the manufacture of feed-pumps, feed-heaters, evaporators, &c. 6800 w. Engng—June 21, 1901. No. 41919 A.

Tools.

Some Points of Experience in Making

Twist Drills, Taps and Dies. Wolfra M. Fox. Illustrates and describes methods used by the author. 1500 w. Am Mach—July 4, 1901. No. 41978.

Tube-Forming Tools. B. J. Dougherty. Illustrates and describes a set of tools for forming taper tubes from tin or other light gage metals. 1500 w. Am Mach—July 4, 1901. No. 41977.

Turret Lathes.

Turret Lathes at the Glasgow Exhibition. Illustrates and describes two of these machines on exhibition which represent the newest designs. 1500 w. Engng—July 5, 1901. No. 42322 A.

Works Management.

See Economics and Industry.

MATERIALS OF CONSTRUCTION.

Cables.

Investigations on Hoisting Machines (Onderzoekingen met de Trekmachine). J. H. Beucker Andreae. Especially discussing the strength of wire hoisting cables, with tabulated data and results of tests. 1800 w. De Ingenieur—July 6, 1901. No. 42247 D.

Testing.

Hydrodynamometers. R. Grimshaw. Describes an instrument peculiarly adapted to measuring the torsion or rotative effect of marine shafts and the lengthwise push on them exerted by the screw which they drive. Ill. 700 w. Am Mach—July 25, 1901. No. 42365.

Wire Rope.

Wire Rope Works at Wakefield. Brief illustrated description of works and methods employed, where steel wire rope is manufactured from pig iron, all the processes being performed on the premises. 2500 w. Engr, Lond—July 12, 1901. Serial. 1st part. No. 42343 A.

POWER AND TRANSMISSION.

Belts.

Power Transmission by Belts. Forrest R. Jones. Illustrated discussion of the different methods of making belt connections, and the advantage of a large angle of wrap and high speed, as compared with a small angle of wrap and low speed. 3500 w. Mach, N. Y.—July, 1901. Serial. 1st part. No. 41956.

Compressed Air.

Air Compressing Plant of the Never Sweat Mine of the Anaconda Copper Mining Co. at Butte, Montana. An illustrated detailed description of Ingersoll-Sergeant Corliss compressors. 1200 w. Compound Air—July, 1901. No. 42041.

New Compressed-Air Vehicles (Nouvelles Voitures à Air Comprimé). G. Boëto. Illustrating and describing the improved compressed-air tram cars introduced on the lines of the General Omnibus Company at Paris. Serial. Part I. 3000 w. 1 plate. Génie Civil—July 13, 1901. No. 42209 D.

Notes on the Selection of an Air Compressor. Gives a list of standard types, with remarks. 1800 w.. Compressed Air—July, 1901. No. 42042.

The New Air Compressors at Pribram (Die Neueren Luftcompressoren in Pribram). J. Divis. An examination of the advantages of compressed air in mining, with a review of recent practice in Bohemia. Serial, Part I. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 6, 1901. No. 42272 B.

Conveyors.

Apparatus for the Mechanical Handling of Material at Paris (Einrichtung für die Mechanische Handhabung von Erzen, Kohlen und Koks auf der Pariser Weltausstellung). Herr Frahm. A full and illustrated review of the exhibits at the Paris Exposition. Three articles, 8000 w. Stahl u Eisen—June 1, 15, July 1, 1901. No. 42250 each D.

Coal and Ash Conveying Gear. R. A. Chattock. Read before the Incor. Munic. Elec. Assn., Glasgow. Describes the conveying apparatus most in use, pointing out their advantages and defects. 3000 w. Elec Rev, Lond—July 12, 1901. No. 42317 A.

The Mechanical Handling of Coal Ore and Pig-Iron. Illustrates and describes some of the best types of plants in use on the Continent. 4000 w. Ir & Coal Trds Rev—July 19, 1901. No. 42400 A.

Elevator.

The Otis Double Power Hydraulic Elevator. William Baxter, Jr. An illustrated description of this system, which is an arrangement to reduce the loss of energy in cases where the average loads are far below the maximum. 1900 w. Am Mach—June 27, 1901. No. 41890.

Hauling Machinery.

Hauling Heavy Machinery Through City Streets. An illustrated discussion of methods. 2000 w. Power—July, 1901. No. 41982.

Power Gas.

See Gas Engineering.

Tide Power.

Tide Mills. An account of some of these mills which successfully utilized the power of the tides, but have been superseded by later inventions or fallen into disuse. 1900 w. Engr, Lond—July 12, 1901. No. 42349 A.

Transporters.

Handling Excavated Material at Jerome Park Reservoir. An illustrated description of modern methods of handling and

transporting materials, the labor-saving devices used, etc. 1000 w. Sci Am—July 6, 1901. No. 41959.

SPECIAL MOTORS.

Alcohol.

See Mechanical Engineeering, Automobilism.

Gasoline.

See Mechanical Engineering, Automobilism.

Oil Engines.

Oil-Engine Trials at Cardiff. Particulars of the oil engines to take part in the trials. 4000 w. Engng—June 21, 1901. No. 41924 A.

Oil Engine Trials at Cardiff. An account of the trials made by the Royal Agri. Soc. of Eng., showing the oil engine to have been wonderfully improved during the past few years. Ill. 3200 w. Engng—June 28, 1901. No. 42059 A.

The Royal Agricultural Society's Show. Illustrated descriptions of a number of oil engines exhibited, and one or two other machines of interest. 4400 w. Engr, Lond —July 5, 1901. No. 42330 A.

See also Mechanical Engineering, Automobilism.

STEAM ENGINEERING.

Boilers.

Babcock and Wilcox boilers at the Glasgow Exhibition. Illustrated description of both land and marine types of these water-tube boilers. 900 w. Engng—June 21, 1901. No. 41920 A.

The Constructive Development of the Dürr Boiler in the German Navy. Von Buchholtz. Translated from *Schiffbau.* Illustrated description of these water-tube boilers as used in a number of German ships. 1600 w. Engng—July 19, 1901. Serial. 1st part. No. 42395 A.

The Parker Steam Generator. Henry G. Morris. Illustrated description of a straight tube boiler with a reversed circulation. 2000 w. Pro Engrs' Club of Phila—July, 1901. No. 42383 D.

Boiler Connections.

Water-Tube Boiler Connections (Les Assemblages des Chaudières à Tubes d'Eau). C. Walckenaer. An examination of the methods of connecting tubes in various forms of water-tube boilers, with a discussion of their merits and defects. 8000 w. Revue de Mécanique—June 30, 1901. No. 42221 E + F.

Boiler Testing.

Boiler Tests with Illinois Coals. L. P. Breckenridge. A report of the results of these tests, with discussion. Ill. 7000 w. Jour W Soc of Engrs—June, 1901. No. 42144 D.

The Value of the Capacity Test in Steam Plant Operation. George K. Hooper. A comparison of tests showing that the highest fuel economy does not always produce the cheapest steam. 3000 w. Engineering Magazine—Aug., 1901. No. 42290 B.

Chimneys.

Notes on the Construction of a Factory Chimney. Wendell Hubbard. Illustrated notes on the erection of a chimney at Camden, N. J. 1200 w. Pro Engrs' Club of Phila—July, 1901. No. 42386 D.

The Construction and Dimensions of Chimneys for Boiler Plants. Abstract of article by G. Lang, in *Zeitschrift d. Ver Deutscher Ing.* Part I. gives rules for determining the height and diameter and thickness of a stack, and explains German practice concerning materials. 3600 w. Eng Rec—July 20, 1901. Serial. 1st part. No. 42173.

The Design and Construction of Factory Chimneys. Francis Schumann. Considers only brick chimneys, discussing the form and dimensions of flue, construction, stability, design, etc. Ill. and general discussion. 6500 w. Pro Engrs' Club of Phila—July, 1901. No. 42385 D.

Circulation.

Effect of Circulation on the Capacity of Fire-Box Heating Surface. Résumé of experiments under the direction of R. C. Carpenter, giving the effect of velocity of circulation on heat absorption. 700 w Eng Rec—July 20, 1901. No. 42178.

Combustion.

A Simple Method of Determining Condition of Combustion, with Suggestions on Working Furnaces. A. Bement. Explanation of a method especially suited to the requirements of regular work. Also discussion. 4000 w. Jour W Soc of Engrs —June, 1901. No. 42143 D.

Combustion and Heat. Angus Sinclair. An explanation of the natural laws that regulate combustion and the theories of heat. 1800 w. Loc Engng—July, 1901. Serial. 1st part. No. 41949 C.

Condensers.

Jet Condensers and Air Pumps (Condenseurs par Mélange et Pumpes à Air). M. J. Nadal. A general study of the various forms of steam condensers which act by the direct contact of the steam with water, as distinguished from surface condensers. Serial. Part I. 4500 w. Revue de Mécanique—June 30, 1901. No. 42219 E + F.

Draft.

Report of Comparative Tests Made With Chimney and Mechanical Blower Drafts. From the Proceedings of the Bavarian Steam Boiler Inspection Society. Describes the tests, and the plant where they were made. Ill. 3500 w. Power—July, 1901. No. 41983.

Fuel Oil.

See Mining and Metallurgy, Miscellaneous.

Gauges.

Construction, Calibration and Care of Steam Gauges. C. W. Obert. Illustrates and describes the principal types, the standards for calibrating and correcting, ways of injuring gauges, etc. 1900 w. Am Elect'n—July, 1901. No. 41972.

Governors.

Progress in the Construction of Shaft Governors (Fortschritte im Baue von Flach reglern). F. Strnad. Illustrating improved forms of disc governors, both of the centrifugal and inertia types. 3000 w. Zeitschr d Ver Deutscher Ing—July 13, 1901. No. 42241 D.

Heating.

Central Heating Plant, Ellis Island, New York. Illustrated description of the power plant and heating system in the large immigrant landing station in New York Harbor. The present article describes the main features of the plant. 3200 w. Eng Rec—July 27, 1901. Serial. 1st part. No. 42409.

The Heating of the Exposition Rotunda at Vienna (Die Heizungsanlage in der Weltausstellungs rotunde zu Wien). G. Kolz. Illustrated description of the high-pressure steam-heating plant installed in the old rotunda of the exposition of 1873, now converted into an auditorium. 2000 w. 1 plate. Gesundheits-Ingenieur—May 31, 1901. No. 42266 B.

Ventilating and Heating the Palace of the Crown Prince of Japan. Illustrated detailed description of the work. 3000 w. Dom Engng—July 15, 1901. No. 42156 C.

Test of Radiators with Superheated Steam. Extracts from paper by R. C. Carpenter, giving results of tests, showing that superheated steam is not so useful as saturated steam for heating. 1300 w. Eng Rec—July 13, 1901. No. 42128.

Pipe Coverings.

Tests of Non-Conductive Coverings for Steam Pipes. D. S. Jacobus. An account of tests made to determine the qualities of a German covering, but giving comparative results with coverings in use in the United States. Also describes apparatus used. 2700 w. Stevens Ind—July, 1901. No. 42429 D.

Piston Speed.

A Piston Speed Chart. Sanford H. Fry. A chart designed to give the piston speed corresponding to various rotative speeds in engines having strokes from 10 to 36 inches in length, with the method of working with it. 900 w. Am Mach—June 27, 1901. No. 41888.

Steam Engines.

The Selection of a Steam Engine. William D. Ennis. Considers points that should receive careful attention before purchasing. 1200 w. Am Elect'n—July, 1901. No. 41973.

Steam Jackets.

Steam Jackets and Their Influence Upon the Efficiency of the Steam Engine. Discusses the conditions under which steam jackets give economical results. 4000 w. Marine Engng—July, 1901. No. 42009 C.

Steam-Making.

On the Science of Steam-Making. John C. Parker. States what the writer considers the principal conditions involved in the evolution of a satisfactory steam generating apparatus, and means of satisfying these conditions. 3600 w. Pro Engrs' Club of Phila—July, 1901. No. 42384 D.

Steam Plant.

Development of a Steam Plant of the Fifties. Alfred H. Schlesinger. Description of a plant and the additions made to the original installation, which gives results in efficiency about equal to those of modern construction. 1000 w. Stevens Ind—July, 1901. No. 42430 D.

Steam Turbine.

The Parson's Steam Turbine in Connection with Alternators (Parson's Stoomturbines als Eenheeden in Wisselstroom Contralen). H. F. Adams. A paper read before the Electrotechnical Section at Amsterdam, discussing mainly the Elberfeld tests. 7500 w. De Ingenieur—June 29, 1901. No. 42246 D.

MISCELLANY.

Aeronautics.

The Conquest of the Air. Brief illustrated account of the air-ship of M. Santos-Dumont, and his trip from St. Cloud around the Eiffel Tower. 500 w. Sci Am—July 27, 1901. No. 42369.

The Santos-Dumont Navigable Balloon. Description, with an account of different trials and the encouraging results. 1500 w. Autocar—July 20, 1901. No. 42381 A.

Aluminothermy.

Recent Applications of the Goldschmidt Process (Neueste Anwendungen des Goldschmidtuschen Verfahrens). Dr. Hans Goldschmidt. Describing the use of the method of producing high temperatures by the combustion of aluminum, to welding, burning castings, and to the production of Chromium and Manganese. 5000 w. Stahl u Eisen—June 1, 1901. No. 42249 D.

Bottle Machinery.

The Mechanical Manufacture of Bottles (Fabrication Mécanique des Bouteilles). A description of the Boucher machine, by which more than 80 perfect glass bottles can be made per hour. 1000 w. Génie Civil—June 29, 1901. No. 42207 D.

Bronze Powder.

The Manufacture of Bronze Powder in Germany. Information concerning this product, used for producing gilt and bronze effects in wood, paper and various metals. 1000 w. U. S. Cons Repts, No. 1087—July 15, 1901. No. 42102 D.

Building Equipment.

The Mechanical Plant of the Newark Free Public Library. Illustrates and describes a plant furnishing power, heat and light for a large library. 4200 w. Eng Rec—July 6, 1901. No. 42030.

The Power Plant of the Newark Public Library. Illustrated description of the apparatus for heating, lighting and other purposes. A correction of an error in printed plan of a former article. 1500 w. Eng Rec—July 13, 1901. No. 42126.

Education.

See Economics and Industry.

Fans.

Air Propellers. Explains the principle of the air propeller and refers to a paper by W. G. Walker describing the tests made to determine the best form of blade for propellers; also gives information on other points. 2800 w. Prac Engr—June 21, 1901. Serial. 1st part. No. 41904 A.

Guns.

Schneider-Canet Quick-Firing Guns and Howitzers for Field Service. Illustrated description of these guns and their latest improvements. 2500 w. Engng—July 19, 1901. Serial. 1st part. No. 42394 A.

The Automatic Gun and Its Military Aspects. Cecil Hamlin Taylor. Examines the general theory and practice of automatic gun construction for the purpose of indicating some of the causes of failure in the past and the probable lines of satisfactory future development. 4200 w. Jour Fr Inst—July, 1901. Serial. 1st part. No. 42005 D.

Heating.

Volume of Water in Hot-Water Heating Apparatus. Abstract of paper by W. M. Mackay, describing tests made to determine the amount of water required per square foot of radiating and heating surface. 1100 w. Eng Rec—July 13, 1901. No. 42127.

Plows.

The History of the Steel Plow. R. L. Andrey. Reviews the history and the improvements since made. 2800 w. Ir Age—July 18, 1901. No. 42147.

Pyrometers.

See Electrical Engineering, Measurement.

Refrigeration.

Trial of Refrigerating Machines at Cardiff. An illustrated description of the machine awarded the prize offered by the Royal Agricultural Soc. of Eng. 1100 w. Engng—June 28, 1901. No. 42058 A.

Typesetting.

A New Typesetting Machine. Illustrated description of a system invented by Alexander Dow. 1000 w. Sci Am—July 20, 1901. No. 42157.

Ventilation.

Ventilation. A. C. Hardy. On the importance of fresh air for the health of mankind, the support of combustion, etc., and the systems of ventilation in use. 4500 w. Dom Engng—July 15, 1901. No. 42155 C.

Wood Screw.

Development of the Wood Screw. Charles D. Rogers. Read before the Providence, R. I., Assn. of Mech. Engrs. Interesting historical sketch. 3000 w. Ir Trd Rev—July 11, 1901. No. 42110.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Belle Ellen Coal Mine, Alabama. William M. Given. Abstract of a paper read before the Engng. Assn. of the South. Descriptive. 1000 w. Eng & Min Jour—July 27, 1901. No. 42425.

British Resources.

Professor Geikie on Our Coal Resources. Review of an article by Prof. James Geikie, published in the *Pall Mall Magazine*, showing the need of more information in regard to the quantities of fuel in the coalfields of the British Islands. 2000 w. Jour Gas Lgt—July 16, 1901. No. 42311 A.

Coal Fields.

The Coal Fields and Seaports of the United States. Edward W. Parker. Their locations in relation to one another, the shipping routes and distances. 3000 w. Mines & Min—July, 1901. No. 42020 C.

Coal Handling.

A New Coal-Tipping Plant. J. Vaclavik, in *Oesterreichische Zeitschrift für Berg. und Hüttenwesen.* Illustrates and describes a plant based on the principle of continuous circulation on the part of the full and empty trucks. 800 w. Col Guard—July 19, 1901. No. 42398 A.

An Improved Coal Handling Plant (Eine Neuartige Kohlensturzanlage). J. Vaclavik. An improved form of over-

head railway, with continuously traveling cars. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 13, 1901. No. 42273 B.

Coal Measures.

A Short Discussion of the Origin of the Coal Measures Fire Clays. T. C. Hopkins. Outlines the theory of their origin and discusses points seemingly opposed to it, giving the author's conclusions. 1700 w. Am Geol—July, 1901. No. 42179 D.

Coke.

Coke as a Substitute for Anthracite Coal. Alton D. Adams. Gives facts showing that a large plant producing coke and coal gas would be able to offer the products much lower than existing prices and that it would supply much of the demand now met by anthracite. 1100 w Sci Am—May 6, 1901. No. 41960.

Colliery Management.

The Management and Control of the Colliery. W. Blakemore. Mr. Blakemore's second paper is devoted to the surface arrangements, and to details of general management. 2500 w. Engineering Magazine—Aug., 1901. No. 42294 B.

Cuba.

On the Bituminous Deposits Situated at the South and East of Cardenas, Cuba. Herbert E. Peckham. Information concerning this field, describing a personal visit to the region, and giving the conclusions reached. 3000 w. Am Jour of Sci—July, 1901. No. 41938 D.

Explosives.

See Mining and Metallurgy, Mining.

Galicia.

The Hard Coal Deposits of Western Galicia (Die Steinkohlenablagerung Westgaliziens). F. Bartonec. A study of the geology of the region, and data concerning the output and quality of the coal. 2 articles, 3500 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—June 15, 22, 1901. No. 42271 each B.

Inclined Seams.

On "The Best and Most Economical System of Working Coal Seams of a Moderate Inclination in South Wales. Ralph Hawtrey. Second Lewis Prize paper, 1900. Illustrates and describes the longwall system, discussing its advantages and applications. Also refers to the pillar and stall system. 8800 w. Ir & Coal Trds Rev—July 5, 1901. No. 42320 A.

Lignite.

Lignite Deposits, or Fields of Brown Coal in North Dakota. R. M. Haseltine. Read before the Ohio Inst. of Min. Engrs. Discusses their extent, thickness and fuel value. 3500 w. Mines & Min—July, 1901. No. 42023 C.

The Brown Coal Industry in Germany and Austria. James Stirling. From the reports issued by the Dept. of Mines of Victoria. Gives the result of personal inspection of the principal brown coal districts of the countries named. Ill. 1300 w. Col Guard—June 28, 1901. No. 42069 A.

Machine Cutting.

Coal-Cutting by Machinery in America. Introduction to a series of articles giving interesting statistics concerning the cost of production. Also editorial. 2800 w. Col Guard—July 5, 1901. Serial. 1st part. No. 42318 A.

Midland District.

Mining in the Midland District in the Nineteenth Century. A. H. Stokes. From the report of the inspector of the mines, showing the first fifty years as a period of slow development and crude methods, and the latter fifty as a period of great development and improved appliances. 6500 w. Col Guard—June 21, 1901. No. 41916 A.

New Zealand.

New Zealand Coal and Oil Company. Brief account of how the shale-works at Orepuki are to be carried on. 1500 w. N. Z. Mines Rec—June 17, 1901. No. 42382 B.

West Virginia.

Coal and Coke Developments in West Virginia. W. G. Irwin. Brief account of the flourishing condition of these industries. 1000 w. Eng & Min Jour—July 20, 1901. No. 42194.

COPPER.

Arizona.

The Copper Queen. Leslie Gillett, in the *Arizona Republican*. Describes these mines of copper-bearing iron ore, methods of mining, etc. 1700 w. Min Rept—July 18, 1901. No. 42182.

Lake Superior.

Lake Superior Copper Production. Horace J. Stevens. Reliable figures from advance returns showing the production for 1900 to be smaller than in any of the four preceding years. 2400 w. Am Mfr—July 18, 1901. No. 42100.

Mexico.

The Copper Mines of Nacosari, Mexico. Describes especially the geology of the district, and the mining conditions. 2000 w. Eng & Min Jour—July 20, 1901. No. 42192.

New Zealand.

The Copper Lode in the Ruahine Range, Near Norsewood, Hawke's Bay. W. A. McKay. Describes the location of this lode in New Zealand, its peculiarities, etc. 2200 w. N. Z. Mines Rec—May 16, 1901. No. 42047 B.

Reduction.

Reduction of Copper Ores in England

and Norway. A report of the treatment of these ores as practiced in the countries named. 1400 w. U. S. Cons Repts, No. 1080—July 6, 1901. No. 41967 D.

Reduction of Copper Ores in France. Report in answer to Department inquiries, concerning the treatment of low-grade copper ores. 4200 w. U. S. Cons Repts, No. 1081—July 8, 1901. No. 41989 D.

Reduction of Copper Ores in Germany. Information concerning the processes used. Illustrates and describes the dry process, the wet process, reduction and refining by electrolysis, &c. 4000 w. U. S. Cons Repts, No. 1079—July 5, 1901. No. 41966 D.

Reduction of Copper Ores in Mexico, Chile, Canada, and Other Countries. Brief notes describing the treatment. 1300 w. U. S. Cons Repts, No. 1084—July 11, 1901. No. 42044 D.

Reduction of Copper Ores in Spain and Austria. Report in answer to Department instruction concerning the treatment in the countries named. 2600 w. U. S. Cons Repts, No. 1082—July 9, 1901. No. 41996 D.

Smelting.

Copper Smelting in British Columbia. A. B. W. Hodges. An illustrated review of the operations of the Granby smelter and proposed improvements. 1800 w. Can Min Rev—June 30, 1901. No. 41-950 B.

Smelting of Siliceous Lead-Copper Ores (Carbonates) at Llano, Sonora, Mexico. Arthur Hauman. Gives the composition of ores and fluxes, explains the peculiarities of available labor, and the methods used. 1200 w. Min & Sci Pr—July 6, 1901. No. 42088.

GOLD AND SILVER.

British Columbia.

The B. C. Mine, Summit Camp, Boundary District. S. F. Parrish. Illustrated description of this mine, yielding gold, silver and copper. 1100 w. Eng & Min Jour—July 20, 1901. No. 42189.

Dredging.

Gold Dredging Operations in California. G. P. Grimsley. Briefly reviews the industry in this State, and describes the Postelthwaite dredge and its operation. Ill. 1300 w. Eng & Min Jour—June 29, 1901. Serial. 1st part. No. 41879.

"Hole-Contract" System.

The Operation of the "Hole-Contract" System in the Center Star and War Eagle Mines, Rossland, B. C. Carl A. Davis. An advance paper to be read before the Am. Inst. of Min. Engs., with editorial. An explanation of this system, discussing its advantages, disadvantages and economic results. 3800 w. Eng & Min Jour—June 29, 1901. No. 41877.

Idaho.

Thunder Mountain, Idaho. William E. L'Hame. An account of a gold mining region which promises great richness. 1500 w. Mines & Min—July, 1901. No. 42025 C.

Klondike.

Mining on the Klondike. A. J. Bowie. Illustrates and describes the mining methods used. 7000 w. Mines & Min—July, 1901. No. 42019 C.

New Zealand.

Mining on the Thames Goldfield. Concerning the correspondence of the reefs on the east and west sides of the Moanataiari Slide. Ill. 1700 w. N. Z. Mines Rec—May 16, 1901. No. 42046 B.

Ore Treatment.

Ore Dressing and Concentration. A. W. Warwick. These terms are explained and their distinction shown, though often used synonymously. 1400 w. Min Rept—July 4, 1901. No. 42002.

Sulphide Ore Treatment. Abstract of a paper read before the Inst. of Min. & Met. An account of experimental work carried out by E. A. Ashcroft and James Swinburne during the past two and a half years. Ill. 1700 w. Elect'n, Lond—July 12, 1901. No. 42314 A.

Queensland.

Ore Treatment in Queensland. W. A. McLeod. Discusses the methods of treatment in detail, the cost, etc. 3000 w. Aust Min Stand—May 30, 1901. Serial. 1st part. No. 42052 B.

Silver-Lead.

Dry Silver-Lead Ores in the Slocan. Illustrated description of the Hewitt mine, Silverton, the ore, methods of mining, etc. 1500 w. B. C. Min Rec—July, 1901. No. 42108 B.

Silverton

The Silverton Mining District, Snohomish County, Washington. R. H. Stretch. An account of various mines in this district, which yield a variety of ores, such as galena, silver, chalcopyrite, etc. 1500 w. Eng & Min Jour—July 27, 1901. No. 42424.

Smelting.

Hot Blast Pyritic Smelting. S. E. Bretherton. Discusses what ores are suitable for pyritic smelting, and the advantages of a hot blast over a cold blast; also describing the author's apparatus. 2500 w. Ores & Met—July, 1901. No. 42099.

The Pride of the West Mill and Smelter, Washington Camp, Arizona. Jesse Scobey. Illustrated description of this property. The ore is complex carrying chalcopyrite, pyrite, zinc blende, galena, garnet, quartz, limestone and calcite. 1500 w. Eng & Min Jour—July 27, 1901. No. 42427.

Tailings.

The Canvas Table Plant of the Mitchell & Mussigbrod Mill at Garnet, Montana. Dr. Peter S. Mussigbrod. Illustrated description of the construction and operation of this table and an account of what it accomplishes. 1100 w. Eng & Min Jour—July 6, 1901. No. 42029.

Veins.

Vein-Structure at the Reynolds Mine, Georgia. G. E. Collins. Read before the Inst. of Min. & Met., in London. Illustrates and describes these gold-bearing veins. 2300 w. Eng & Min Jour—July 20, 1901. No. 42193.

IRON AND STEEL.

Iron.

See Electrical Engineering, Electrochemistry.

Manganese.

Effects of Variations in Manganese on Different Grades of Iron. Thomas D. West. Outlines the method of testing and gives results. 2000 w. Ir Trd Rev—July 11, 1901. No. 42111.

Manganese Ore in the Caucasus. Interesting particulars of the mining of this ore. 1400 w. Col Guard—June 21, 1901. No. 41917 A.

On the Manganese Ore Deposits of the Queluz (Lafayette) District, Minos Geraes Brazil. Orville A. Derby. Describes the deposits and discusses their origin, giving reasons for conclusions reached. 5400 w. Am Jour of Sci—July, 1901. No. 41937 D.

Ontario.

The Iron Ore Fields of Ontario. Willet G. Miller. A review of the iron ore deposits, giving illustrations and outline map, and showing the Province to have a great future as an ore-producing country. 7800 w. Can Min Rev—June 30, 1901. No. 41951 B.

Ore.

Iron Ore Supplies. Editorial discussion of a statement made by Mr. Schwab in his evidence before the Industrial Commission in regard to the iron ore deposits of the United States. 1800 w. Engng—July 5, 1901. No. 42325 A.

Ore Handling.

Ore Handling Machinery on the Great Lakes. James N. Hatch. A fully illustrated account of the mechanical appliances which have become such an important factor in American ascendancy in steel making. 3500 w. Engineering Magazine—Aug., 1901. No. 42288 B.

Pennsylvania.

The Cornwall Ore Hills of Pennsylvania. An illustrated historical review of this valuable iron ore property. 5500 w. Ir Age—July 18, 1901. No. 42146.

Pneumatic Feed.

Pneumatic Cone Mechanism (Pneumatischer Gichtglocken Aufzug). E. Nümker. An illustrated description of the application of a pneumatic cylinder for operating the feed cone of a blast furnace. 600 w. Stahl u Eisen—July 15, 1901. No. 42256 D.

Power Gas.

See Gas Engineering.

Statistics.

See Economics and Industry.

Steel Specifications.

Proposed Standard Specifications for Steel for Bridges, Ships, Forgings and Railway Rails. A copy of the specifications for purposes named as formulated by a committee of the International Assn. for Testing Materials. 4000 w. Eng News—July 4, 1901. No. 41993.

Steel Works.

The New Steel Works at Niederschelden on the Sieg (Die Neuen Stahlwerksaulgen zu Niederschelden a. Sieg). With photographs and plans of the new steel plant of the Charlottenhütte. 1800 w. Stahl u Eisen—July 15, 1901. No. 42255 D.

The Works of the Dominion Iron & Steel Co. at Sydney, Cape Breton. Illustrated detailed description of this recently completed plant. 3500 w. Eng News—July 25, 1901. No. 42374.

Urals.

The Iron Industry of the Southern Urals (La Sidérurgie dans l'Oural Méridional). M. A. Gouvy. An account of the existing furnaces and a description of the riches of the region and its need of railway communication. 15000 w. 3 plates. Mem Soc Ing Civ de France—May, 1901. No. 42218 G.

The Manufacture of Pig Iron in the Southern Urals (Die Grundlagen zur Roheisenerzeugung in Südlichen Ural). A. Gouvy. With map of the region and data concerning the present manufacture. Vast beds of ore would be made available if railways were built. 2500 w. Stahl u Eisen—July 1, 1901. No. 42254 D.

Water Cooling.

A Water-Cooled Blast-Furnace Book. Axel Sahlin. Read before the Iron & Steel Inst. Illustrates and describes a device which consists of a plate shell in the shape of an inverted frustum. 1800 w. Engng—July 12, 1901. No. 42340 A.

MINING.

Austria.

Mining in Austria. H. R. Jastrow. Concerning the production of the various

minerals, and interesting facts relating to the mining industry. 1000 w. Eng & Min Jour—July 27, 1901. No. 42426.

British Columbia.

The Mineral Production of British Columbia. Abstract of the report of William Fleet Robertson, the Provincial metallurgist. 3500 w. Eng & Min Jour—July 20, 1901. No. 42191.

Compressed Air.

See Mechanical Engineering, Power and Transmission.

Deposits.

Genesis of Ore Deposits. Matt. W. Alderson. Outlines conclusions reached, and maintains that all mineral deposits were formed by streams flowing on the surface of the earth at the time the deposits were made. 3000 w. Min & Sci Pr—July 6, 1901. Serial. 1st part. No. 42087.

Drainage.

Mine Drainage. On the various systems of pumping, especially emphasizing the advantages of the electric pump. Ill. 2000 w. Min Rept—July 4, 1901. No. 42003.

Explosives.

Explosives in Coal Mines. A list of explosives added to the special list of permitted explosives in British mines. 2000 w. Col Guard—June 28, 1901. No. 42066 A.

Flameless Explosives and Coal Dust. James Ashworth. An account of the explosion on April 19, in the Four-feet mine of the Walthew House Colliery, near Wigan. 2100 w. Col Guard—July 5, 1901. No. 42319 A.

The Employment of Safety Explosives in Fiery Mines. P. Chalon, in *Revue* Technique. Discusses their advantages and defects, and the practical means of testing. 2500 w. Col Guard—June 28, 1901. No. 42067 A.

The Use of Safety Explosives (Emploi des Explosifs de Sureté). P. Chalon. A review of the nature and behavior of mining explosives adapted for safe use in gaseous mines. 2500 w. Revue Technique—June 10, 1901. No. 42229 D.

Fire Damp.

An Electric Fire Damp Indicator (Sur un Grisoumetre Electrique). G. Leon. The apparatus depends for its action upon the difference in electrical resistance between two platinum wires, heated by the same current, and placed, one in air, the other in the fire damp. 1200 w. Comptes Rendus—June 10, 1901. No. 42244 D.

Haulage.

Mine Locomotives. W. B. Clarke. A comparison of the efficiencies and relative cost of installations of electricity and compressed air. 2200 w. Mines & Min—July, 1901. No. 42024 C.

Self-acting Haulage in Fifeshire. Philip Hodge. Read before the British Soc. of Min. Students. Illustrates and describes systems for bringing coals from a higher to a lower level. 2700 w. Ir & Coal Trds Rev—July 19, 1901. No. 42399 A.

Life Saving.

Automatic Life-Saving Apparatus (Automatischer Sauerstoff Rettungsapparat). Dr. L. Michaelis. An illustrated description of the 1901 Model of the Giersberg apparatus, carrying compressed oxygen, and an absorbent of carbonic acid. 1500 w. 1 plate. Glückauf—June 22, 1901. No. 42669 B.

Ore Treatment.

Ore Dressing and Concentration. A. W. Warwick. Discusses the methods of separation of various kinds of ores. 1700 w. Min Rept—July 11, 1901. No. 42139.

Pumping.

See Electrical Engineering, Power Applications.

Quarrying.

Stripping. Frank W. Hoyt. Some general suggestions based upon experience. Ill. 2500 w. Quarry—July 1, 1901. No. 42094 A.

Quebec.

The Mineral Production of Quebec. From the report of J. Obalski, inspector of mines for the Province. 1400 w. Eng & Min Jour—July 20, 1901. No. 42190.

Safety Devices.

Safety Appliances at the Exposition of 1900 (Les Appareils de Securité à l'Exposition de 1900). H. Schmerber. Discussing especially the safety appliances used in connection with mining hoists, etc. Serial. Part I. 2000 w. 1 plate. Génie Civil—June 29, 1901. No. 42205 D.

Safety Lamps.

Experiments on the Penetrability of Safety Lamps (Durchblaseversuche mit Sicherheitslampen). H. Fändrich. An examination of the resistance offered by the wire gauze of safety lamps to the penetration of gases under pressure. Two articles. 7500 w. 2 plates. Glückauf—June 8 and 15, 1901. No. 42268 each B.

Shaft Sinking.

Sinking Through Swamp, Clay and Sand at Huntly, Waikald District. William Tottley. Describes the difficulties met in a New Zealand coalfield. 2200 w. N. Z. Mines Rec—May 16, 1901. No. 42-048 B.

The Application of the Freezing Method in Shaft Sinking at Limburg (De Toepassing der Bevriesmethode bij het Maken van Schachten in Limburg). J. Koster. Describing the application of the Honigmann process for sinking a shaft 320 feet

deep in sand. 5000 w. De Ingenieur—July 13, 1901. No. 42248 D.

Surveying.

See Civil Engineering, Measurement.

United States.

The Mineral Production of the United States. Tables and general comments. 5800 w. Eng & Min Jour—June 29, 1901 No. 41878.

MISCELLANY.

Aluminum.

Improvement in the Metallurgy of Aluminum. Clinton Paul Townsend. Concerning the electric furnace methods for the purification of bauxite, which will probably reduce the cost of aluminum of certain grades. 1200 w. Elec Wld & Engr—July 6, 1901. No. 42084.

Bauxite.

Bauxite in New South Wales. A report of the known deposits with analysis. 350 w. U. S. Cons Repts, No. 1100—July 30, 1901. No. 42410 D.

Carnotite.

The Commercial Treatment of Carnotite. J. Ohly. Description of the chemical concentration of the values contained in this mineral. The instruction is limited to the extraction of uranium values exclusively. 2000 w. Min Rept—July 25, 1901. No. 42380.

Charcoal.

By-Products from Charcoal. Frank H. Mason. The products from various woods and how they are obtained and marketed. From the U S Cons Repts. 3500 w. Mines & Min—July, 1901. No. 42022 C.

Diamonds.

Australian Diamond Washing. Describes the care taken in the washing of diamondiferous gravels. 900 w. Min Rept—June 27, 1901. No. 41943.

Fuel Oil.

Tests of Texas and California Fuel Oils. Howard Stillman, in the *N. Y. Commercial.* Reports the tests of the Southern Pacific R. R. Co., which has used fuel oil for locomotive service for several years. 900 w. Eng News—July 11, 1901. No. 42116.

Opals.

Australian Opal and Opal Mining. John Plummer. Concerning the difficulties of prospecting, the value and points determining it. 1000 w. Min Rept—July 18, 1901. No. 42183.

Petroleum.

Origin of Petroleum. A statement of various theories which have been proposed and some of the facts in support of them. 2000 w. Mines & Min—July, 1901. No. 42021 C.

The Great Oil Well Near Beaumont, Texas. Anthony F. Lucas. Gives an account of the discovery and method of controlling the well, the hydraulic system of boring, the geology of the region and the product obtained. Ill. 4800 w. Am Mfr—July 11, 1901. No. 42104.

The Petroleum-Bearing Rocks of Poverty Bay and East Cape Districts. From the report of the government geologists, describing the district. 3700 w. N. Z. Mines Rec—May 16, 1901. No. 42045 B.

Philippines.

The Mineral Resources of the Philippines. Information concerning the minerals and other products of these islands. 2500 w. Am Mfr—July 11, 1901. No. 42105.

Pyrometers.

See Electrical Engineering, Measurement.

Spain.

Coal and Iron in Spain. Information relating to imports and exports. 1500 w. Col Guard—July 12, 1901. No. 42333 A.

Zinc.

The New Zinc Field. Waldon Fawcett. Information concerning the Missouri-Kansas district, the peculiarities, the cleaning of the ore, etc. 1300 w. Sci Am—July 13, 1901. No. 42092.

Zinc Mining in Kansas. Harry L. Wohlford. Gives the early history of this district, describes the ores, the modern methods and output. Ill. 1000 w. Sci Am—July 13, 1901. No. 42089.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in May. Detailed list and classified summary. 3700 w. R R Gaz—July 12, 1901. No. 42120.

High Speed.

The Alleged "Railway Race." Charles Rous-Marten. On misconceptions appearing in the British daily papers and how they have arisen, with a statement of facts. 2800 w. Engr, Lond—July 5, 1901. No. 42331 A.

The American Locomotive as a High-Speed Machine. E. P. Watson. A discussion of future possibilities in railway speeds, showing the track rather than the engine to be in need of improvement. 3500 w. Engineering Magazine—Aug., 1901. No. 42291 B.

St. Louis.

Street Railway Progress in St. Louis. An illustrated article dealing with present progress, past improvements, consolidations, management, etc. 5600 w. St Ry Jour—July 6, 1901. No. 42037 D.

Syracuse, N. Y.

Street Railway Evolution in Syracuse. E. G. Connette. An account of how the improved conditions in this city were brought about. 2500 w. St Ry Jour—July 6, 1901. No. 42039 D.

Train-Despatching.

Simplification of Train-Despatching. Editorial on the changes made in the time-tables of the Chicago, Burlington & Quincy R. R. 2500 w. R R Gaz—July 19, 1901. No. 42154.

FINANCIAL.

Connecticut.

Railway Interests in the Connecticut Legislature. Clarence Deming. A review of the steam-trolley conflict of the last decade. 1500 w. R R Gaz—July 19, 1901. No. 42151.

Statistics.

Statistics of Railways of the United States for the Year Ending June 30, 1901. Abstract of the report of the Inter-state Commerce Commission, giving figures of interest in regard to mileage, equipment, employees, service, earnings, accidents, etc. 1600 w. Eng News—July 18, 1901. No. 42166.

MOTIVE POWER AND EQUIPMENT.

Birmingham, Eng.

Electric Traction in Birmingham. Illustrated detailed description of the first overhead trolley system in this city, which is an example of the best construction. 1700 w. Tram & Ry Wld—June 13, 1901. No. 42049 B.

Brakes.

Braking Apparatus for Electric Cars. A. L. C. Fell. Discusses car brakes under six heads; hand, friction, slipper, pneumatic, electromagnetic, and Newell electromagnetic brakes. 1500 w. Elec Engr, Lond—June 28, 1901. No. 42056 A.

Recent Practice in Freight Train Braking. Editorial on the application of air-brakes to freight cars, the practice in making up trains where all cars are not fitted, points for improvement, etc. Eng News—July 4, 1901. No. 41992.

The Siemens Electric Control for Air-Brakes (Ueber die Elektrische Steuerung für Luftdruck bremsen). H. Wagner. A description of the electric control intended to give more rapid action than the triple valve, the apparatus is designed for use on the proposed military railway between Berlin and Süterbog. Serial, Part I. 3000 w. Glaser's Annalen—July 15, 1901. No. 42261 D.

Brake Shoes.

The Brake Shoe Tests. F. W. Sargent. Facts and theories from a study of the record of the Laboratory Tests of the M. C. B. Assn. Describes the material of the competing shoes, and their action under test. Diagrams. 3000 w. R R Gaz—July 12, 1901. No. 42118.

Cable Line.

Cabling the Edinburgh Tramways. Illustrates and describes the distinguishing features of this work now nearing completion. 3000 w. Engr, Lond—July 12, 1901. Serial, 1st part. No. 42341 A.

Cars.

80,000-lbs. Capacity Box Cars of the Atchison, Topeka, & Santa Fe. Illustrated description. 700 w. R R Gaz—July 26, 1901. No. 42377.

Forty-Ton Hopper Bottom Coal Cars, C. B. & Q. R. R. Illustrations of new cars now building which show novel features. 500 w. Ry & Engng Rev—July 13, 1901. No. 42140.

Freight Cars for the North of Spain Railroad. Brief illustrated description. 500 w. R R Gaz—June 28, 1901. No. 41893.

Increasing the Capacity of Freight Cars (Ueber die Erhöhung der Ladefähigkeit der Offener Güterwagen). H. Schwabe. A discussion of the commercial importance of large cars and automatic unloading methods, based mainly on American practice. 4000 w. Stahl u Eisen—June 1, 1901. No. 42251 D.

100,000 Pounds Capacity Steel Hopper Cars. The specially interesting features of the design given are the light weight of the car and the method of construction in which the center sills are made of light sections, reinforced by truss rods. Ill. 800 w. Am Engr & R R Jour—July, 1901. No. 41980 C.

Draft Gear.

Draft Gear. From a committee report to the Master Car Builders' Assn. at the Saratoga meeting. Considers design, materials, tests, etc. Ill. 2600 w. Ry & Engng Rev—June 29, 1901. No. 41952.

Electric Traction.

Electric Railways. Major P. Cardew First of a series of Cantor Lectures. Gives a brief historical summary of practical electric railways in Europe; discusses the advantages of electric traction, and details of operation. 9000 w. Jour Soc of Arts—July 12, 1901. Serial. 1st part. No. 42196 A.

Multiple-Unit Traction (La Traction à Unités Motrices Multiples). A description of the system of the French Thomson-

Houston Company as used on the Meudon railway, France. 1800 w. Revue Technique—June 25, 1901. No. 42230 D.

On Polyphase Generating and Sub-Station Plant for Electric Traction. H. S. Meyer. Discussing points in article by A. C. Eborall. 1800 w. Elec Rev, Lond—July 5, 1901. No. 42315 A.

European Railways.

European Railway Jottings. Charles Rous-Marten. Concerning the American engines furnished for the Midland railway, and the qualities of British and American locomotives. 2000 w. Loc Engng—July, 1901. No. 41948 C.

Fuel Consumption.

Suggested Methods for Reducing Locomotive Fuel Consumption. Abstract of a report presented to the Am. Ry. Mas. Mech.'s Assn. Considers means along which economy may be secured. Also editorial on feed-water heating for locomotives. Ill. 4300 w. Eng News—June 27, 1901. No. 41885.

Locomotives.

American Locomotives in England. A discussion of Mr. Rous-Marten's article in defense of American locomotives. 1800 w. Engr, Lond—June 28, 1901. Serial. 1st part. No. 42071 A.

A New Mogul for the New York, Ontario & Western. Illustrated description. 600 w. R R Gaz—July 26, 1901. No. 42378.

"Chautauqua" Type Passenger Locomotive; Chicago, Rock Island & Pacific Ry. Illustrations and details of a recently built engine. 700 w. Eng News—July 11, 1901. No. 42112.

Combustion in Locomotives. Letters and editorial commenting on Mr. Rous-Marten's article comparing American and British engines. 3400 w. Engr, Lond—June 21, 1901. No. 41929 A.

Dutch Locomotives. J. Janette Walen. Illustrates and describes engines used by the Dutch State Railways. 1000 w. Ry & Loc Engng—July, 1901. No. 41945 C.

Express Locomotives, South-Eastern & Chatham Railway. Gives illustrations and principal particulars of bogie express engines. 600 w. Engr, Lond—July 19, 1901. No. 42393 A.

Express Locomotive for the South-eastern and Chatham Railway; Glasgow Exhibition. Ilustrated description, giving dimensions. 900 w. Engng—June 21, 1901. No. 41922 A.

Heavy Express Locomotive (Locomotive Express pour Trains Lourds). An illustrated description of the 10-wheel passenger locomotive exhibited at Paris by the North Eastern Railway. 1800 w. 1 plate. Génie Civil—June 22, 1901. No. 42204 D.

Relative Merits of British and American Locomotives. Editorial on the recent controversy over the American locomotives sold to railway companies abroad. 1300 w. Loc Engng—July, 1901. No. 41947 C.

Richmond Compound Locomotives for the Rio Grande Western. Illustrated description. 500 w. R R Gaz—June 28, 1901. No. 41892.

The High Speed Steam Locomotive (Die Dampflokomotive für Grosse Geschwindigkeit). H. von Borries. An examination of the lines along which improvement may be expected, with a review of the study of Fränkel upon the same subject. 1000 w. Glaser's Annalen—June 15, 1901. No. 42258 D.

The Italian Locomotives at the Exposition of 1900 (Les Locomotives Italiennes á l'Exposition de 1900). F. Barbier. Illustrated description of the three engines exhibited. 2000 w. 2 plates. Rev Gen des Chem de Fer—June, 1901. No. 42226 H.

Three-Cylinder Compound Locomotive for the North-Eastern Railway. Illustrated detailed description of an engine which can be worked as a simple engine, as a semi-compound, or a compound. 2000 w. Engng—July 5, 1901. No. 42323 A.

Trials of an Italian Locomotive on a French Railway. An account of the trials of a locomotive exhibited at Paris, designed to run cab first, and the favorable results. 3000 w. Engr, Lond—July 12, 1901. No. 42346 A.

Wide Firebox Locomotive for Burning Anthracite Culm; Delaware, Lackawanna & Western R. R. Illustrated description of a passenger engine now building. 500 w. Eng News—July 25, 1901. No. 42376.

London Tramways.

Electric Tramways in London. An account of London's first electric line, the large patronage, power, &c. 2500 w. Engng—July 12, 1901. No. 42338 A.

London United Tramways. Begins an account of this great undertaking of providing constant inter-communication between London and its western suburbs. 2500 w. Elec Rev, Lond—July 19, 1901. Serial. 1st part. No. 42417 A.

The London United Electric Tramways. Illustrated description of interesting features. 1600 w. Engr, Lond—July 19, 1901. No. 42392 A.

Manchester, Eng.

Manchester Corporation Tramways. General notice of the undertaking and illustrated description of the section now open. 2900 w. Tram & Ry Wld—June 13, 1901. No. 42051 B.

Oil Fuel.

Burning Oil in Locomotives. H. M. Honn. Illustrates and describes the equipping of an engine for oil fuel, and the

successful firing. 800 w. Soc Engng—July, 1901. No. 41946 C.

Power Consumption.

The Watt-Hour Consumption of Electric Railways (Berechnung des Wattstundenverbranches Elektrischer Bahnen). E. E. Volkers. The various elements of resistance are taken into account, and it is shown that an efficiency of 58 per cent. is practicable. 4500 w. Elektrotech Zeitschr—June 13, 1901. No. 42275 B.

Railway Apparatus.

The Westinghouse Electric Brake and Heater. Illustrated description of the arrangement and construction of the apparatus, the method of attaching the brake rigging to the truck, &c., with a statement of the advantages. 1200 w. R. R. Gaz—June 28, 1901. No. 41891.

Splicing Sills.

Splicing Sills in Long Passenger Equipment. From the topical discussion of the M. C. B. convention. Ill. 1000 w. Ry & Engng Rev—July 6, 1901. No. 42027.

Springs.

Revision of Recommended Practice for Springs, including Design for Springs for 100,000-Pound Cars. Committee report to the M. C. B. Assn. Ill. 1000 w. Am Engr & R R Jour—July, 1901. No. 41981 C.

Underground.

Proposed Underground Electric Railways for Buenos Ayres. L. D. Tandy. An illustrated description of this beautiful South American city, with an account of the tramway situation, and the possibilities of the proposed underground railway. 4200 w. Tram & Ry Wld—June 13, 1901. No. 42050 B.

Valteline.

The Valteline Electric Railway (Chemin de Fer Electrique de la Valteline). H. Martin. A very full description of the three-phase high pressure system, as applied to 65 miles of main-line railway. 3500 w. 1 plate. Génie Civil—June 15, 1901. No. 42200 D.

Wheels.

Cast-Iron Wheels. Committee report to the Master Car Builders' Assn. Ill. 900 w. Ry & Engng Rev—June 29, 1901. No. 41953.

NEW PROJECTS.

Africa.

Lagos Government Railway. The terminal station is located on Iddo Island, and the connection with the main land and Lagos is made by bridges. Particulars of the Carter bridge, which is over 2200-ft. in length, are given. Ill. 2200 w. Engr, Lond—June 28, 1901. No. 42072 A.

Korea.

New Korean Railway. A statement extracted from the *Japan Daily Mail*, concerning the proposed Seoul-Fusan Railway, which is now being surveyed. 1000 w. U S Cons Repts, No. 1096—July 25, 1901. No. 42351 D.

Switzerland.

The New Lines of Rhaetian Railway. (Die Neuen Linien der Rhätischen Bahn). H. Hennings. With topographical maps and profiles of the new line between Thusis and St. Moritz, and plans of the loop tunnels and other construction work. Serial, Part I. Schweizerische Bauzeitung—July 6, 1901. No. 42265 B.

PERMANENT WAY AND BUILDINGS.

Boston Elevated.

The Boston Electric Elevated Railway. Illustrated notes on the equipment of the Boston Elevated Railway Company's new lines, power stations and trains. 1500 w. Elec Rev, N. Y.—June 29, 1901. No. 41880.

Construction.

Construction on the Clinch Valley Division, Norfolk and Western R. R. Illustrated descriptions of particular portions of the work, with summary taken from Mr. Low's paper, in the *Pro. of the Am. Soc. of Civ. Engrs.* 2000 w. Ry & Engng Rev—July 20, 1901. No. 42188.

The Railway from Toul to Pont Saint-Vincent (Ligne de Toul à Pont Saint-Vincent). M. Descubes. A general description of the construction of a new branch line of the Eastern Railway of France. Serial. Part I. 7500 w. 1 plate. Rev Gen des Chem de Fer—May, 1901. No. 42222 H.

Freight Station.

Central Ave. Freight Station at Cincinnati; C. C. C. & St. L. Ry. Illustrated description of rapid construction work. 1500 w. Eng News—July 4, 1901. No. 41995.

New York Elevated.

Construction of the Manhattan Elevated Railway in New York (Bau Konstruktion der Manhattan-Hochbahn in New York). F. M. von der Werra. A fully illustrated account of the structural work on the elevated railway in New York. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—June 22, 1901. No. 42235 D.

Rapid Transit Ry.

Section Four of the New York Rapid Transit Railway. Illustrates and describes the methods of work in rock tunnel. 3500 w. Eng Rec—June 29, 1901. No. 41963.

Signals.

Auxiliary Electric Motor (Servo-Moteur Electrique.) M. Rouby. A description of an arrangement of electric motor for assisting in the movement of the levers of the Vignier and Saxby signalling ap-

paratus. 1800 w. Rev Gen des Chem de Fer—May, 1901. No. 42224 H.

Electric Interlocking near Sixteenth Street, Chicago. Illustrated description of one of the largest plants ever installed in the United States. 1600 w. R R Gaz—July 12, 1901. No. 42119.

Signaling a Railroad. George W. Blodgett. Outlines a plan for spending a limited amount of money for signaling purposes to advantage. Ill. 2300 w. R R Gaz—July 26, 1901. No. 42379.

Snow.

Snow Clearance. On the methods employed to keep street railways open where the fall of snow is large. 2000 w. Elec Rev, Lond—June 21, 1901. No. 41915 A.

Suspension Ry.

Suspension Railway at Loschwitz, Saxony. Brief account of a new mountain-railway, opened in May, with illustration. 450 w. U S Cons Repts, No. 1076—July 1, 1901. No. 41894 D.

The Barmen-Elberfeld-Vohwinkel Suspended Railway (Die Schwebebahn Barmen-Elberfeld-Vohwinkel). G. Lüdorf. A full description of the road with especial attention to the electrical details. 7000 w. Elektrotech Zeitschr—June 27, 1901. No. 42279 B.

Terminal.

The Mechanical Plant at the Boston South Terminal (Die Stellwerkanlage des Bostoner Süd-Bahnhofes). Prof. F. Reuleaux. A detailed account of the whole plant with many illustrations. Two articles. 1 plate. 4000 w. Glaser's Annalen—July 1, 15, 1901. No. 42260 each D.

Third-Rail.

The Albany and Hudson Railroad. An illustrated article giving operative details of the largest third-rail electric railway system in the world. 2500 w. Elec Rev, N. Y.—July 20, 1901. No. 42185.

Tramways.

Permanent Way for Electric Tramways. W. Howard-Smith. Read at Leicester meeting of the Incor. Assn. of Munic. & Co. Engrs. Discusses the details of a well-designed track. Ill. 4500 w. Elec-Engr, Lond—July 19, 1901. Serial. 1st part. No. 42416 A.

Transfer Table.

Electric Transfer Table (Chariot Electrique à Niveau). M. Sabouret. A description of the transfer table used in the new station of the Orleans railway at Paris for handling the electric locomotives. The construction avoids the use of a depressed track. 2000 w. 1 plate. Rev Gen des Chem de Fer. May, 1901. No. 42223 H.

Transfer Table Without Pit (Chariot Roulant Sans Fosse). M. Cartault. A description of the electric transfer table used by the Paris, Lyons, Mediterranean Railway; constructed without requiring a pit or depression for the tracks for the table. 2000 w. 1 plate. Rev Gen des Chem de Fer—June, 1901. No. 42225 H.

Tunnels.

See Civil Engineering, Construction.

Tunnel Ventilation.

The Ventilation of Railway Tunnels Under City Streets. Editorial discussion of the complaints in regard to the tunnels leading to New York. 2300 w. Eng News—July 11, 1901. No. 42117.

Versailles.

The New Railway from Paris to Versailles (Novelle Ligne de Paris à Versailles). A. Dumas. With map and profile of the road, and many views of stations and bridges on the section from Issy-les-Moulineaux to Meudon-Val-Fleury. 4000 w. 1 plate. Génie Civil July 6, 1901. No. 42208 D.

Vienna.

The Metropolitan Railway of Vienna (Le Chemin de Fer Métropolitain de Vienne). René Philippe. A very full account of the municipal railway, elevated surface and tunnel, and its suburban connections, in Vienna. Serial. Part I. 9000 w. 4 plates. Rev Gen des Chem de Fer—June, 1901. No. 42227 H.

Wabash.

A Wabash Cut-Off. An illustrated account of a new line under construction between Montpelier and Maumee, O. 1000 w. Ry Age—July 19, 1901. No. 42181.

TRAFFIC.

Freight.

Improvement in Handling of Freight. J. Rothschild. Outlines a plan used on a large railroad system, which has proved satisfactory. 1500 w. Ry & Engng Rev—July 6, 1901. No. 42028.

Loading.

Loading Long Material. Tables and directions prepared by Mr. Pulaski Leeds, for the loading of lumber, logs and stone on open cars and carrying structural material, girders, &c. 1000 w. Ry Age—July 12, 1901. No. 42138.

Ore-Carrying.

A Novel Ore-Carrying Railroad. Waldon Fawcett. Notes on the interesting features of the Pittsburg, Bessemer & Lake Erie Railroad. 1100 w. Sci Am—July 27, 1901. No. 42368.

Train Loads.

Increasing the Revenue Train Load by the Use of Large Capacity Cars and Improvements in Construction and Maintenance of Details. F. F. Gaines, with general discussion. 1200 w. N Y R R Club—May 16, 1901. No. 42098.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Automobile.

The Construction of a Gasoline Motor Vehicle. By C. C. Bramwell. Size, 6 in. by 9 in.; pp. 149. Price, $2.00. New York: Emil Grossman & Bro.

A very useful book, containing the detailed history of the construction of a gasoline motor vehicle, with drawings of the parts, and all the necessary information to enable what has proved to be a successful machine to be repeated.

Directory.

The Argentine Commercial Guide and English Directory. Size, 5 in. by 7½ in.; pp. 498. Price, 5 shillings, $1.50, $3.00 Argentina paper. London and Buenos Aires: John Grant & Son.

A useful and handy reference book to the statistics, institutions, government information, banking, railways, and industrial data of the Argentine Republic, with an alphabetical list or directory of more than 100 pages of the English-speaking residents throughout the country.

Hydrodynamics.

Water Power: An Outline of the Development and Application of the Energy of Flowing Water. By Joseph P. Frizell. Second edition. Size, 6 in. by 9 in.; pp. 584. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

A new and enlarged edition of this important work, treating very fully of the subject in which interest has been so greatly revived. The new matter is given in the form of an appendix, and treats of testing flumes and testing mechanism for water-wheels; the development of water power by means of tunnels; and of the action of governors and regulators.

Metric System.

Le Système Métrique des Poids et Mesures. G. Bigourdan. Size, 6 in. by 9 in.; pp. 458. Price, 10 francs, 8 shillings, $2.00.

An exhaustive study of the metric system, including the enactments which led to its establishment, with accounts of the preliminary astronomical and geodetic work and a history of the operations which were required in the determination of the metre and the kilogramme. The various enactments in connection with the official adoption of the system by different governments are given, together with the history of its propagation down to the year 1900.

Sewerage.

The Designing, Construction, and Maintenance of Sewerage Systems. By A. Prescott Folwell. Fourth edition. Size 6 in. by 9 in.; pp. 445. Price, $3.00. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

A very full treatment of both the combined and separate systems of sewerage, discussing the methods of collecting the preliminary data, preparing the design, and executing the construction. In the present enlarged edition, increased space has been given to the subject of sewage disposal, bringing the account into accord with the latest conclusions of recognized authorities.

Torpedoes.

Torpedoes and Torpedo-Vessels. By Lieut. G. E. Armstrong, late R. N. Size, 5 in. by 7½ in.; pp. 306. Price, 5 shillings, $1.50. London: Geo. Bell & Sons.

The primary object of the book is to convey to the general reader an elementary knowledge of the most modern development of naval warfare—the science of torpedoes. In this, the second and revised edition, a full account is given of the plans and specifications of the improved Holland boat now building for the British navy. The principle of the gyroscope in the Whitehead torpedo is also explained.

Water Supply.

Water Storage, Cache Creek, California, By Albert E. Chandler. Size 6 by 9 in.; pp. 48. U. S. Geological Survey, Washington, D. C., U. S. A.

Pamphlet No. 45 in the series of Water-Supply and Irrigation papers, giving the results of a study of the storage possibilities for water-supply and irrigation uses of Cache Creek Basin, California, having a drainage area of about 1,200 square miles. Much information is given as to topography, rainfall, existing irrigation works, dam sites, etc., but with a marked lack of logical order in presentation or definiteness in conclusion.

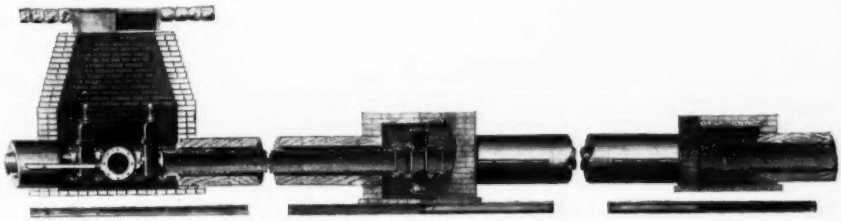
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Holly System of Steam Distribution.

In 1877 about a mile of underground mains was established at Lockport, N. Y., for distributing steam for heat and power. Lockport was then a city of about 20,000 inhabitants and five stores, seven residences, and two churches were connected on the system. Nearly every year since then a few hundred or a few thousand feet of experimental mains have been added to the first installation, in which every known method of insulation and numerous devices have been put to practical test. During these twenty-four years the number of customers has been steadily increasing, so that at the present time steam is being furnished to about 325 consumers in both residences and business blocks.



SECTION OF UNDERGROUND STEAM MAIN.

The subject of exhaust-steam heating appeals especially to power companies, who either regard their exhaust steam as a wasted by-product, or one for which they get but small compensation by the use of condensers. It is a well-known fact that nearly ten times as many heat units in the form of steam must be generated as can be converted into mechanical energy through the medium of the steam engine, *i. e.*, we find flowing from the exhaust pipe of the engine nearly 90 per cent. of the steam after doing its power work, and which, in addition to heating feed water, is available for heating buildings. The Holly system takes this valuable product and turns it to practical account. It is the impression with some that exhaust steam is saturated with moisture, and that it does not contain an equal number of units of heats as compared with live steam. This is a fallacy. Steam at equal pressures has equal temperatures. To illustrate: Exhaust steam at 5 pounds pressure taken directly from the engine cylinder has a temperature of 227.95 degrees—no more, no less; steam taken directly from the boiler at 5 pounds pressure has exactly the same temperature.

It is demonstrated from actual practice that the exhaust steam from each 100 horse-power of engines operated will heat from 1,000,000 to 1,300,000 cubic feet of space in average buildings in severe winter weather, and that a fair commercial rate to charge for such heating depends upon the price of fuel in competition, varying from $2.50 to $5.50 per 1,000 cubic feet of space for the heating season. It will thus be seen that this waste product can, when distributed to heat buildings, produce a revenue of from $2,500 to $6,000 per annum per 100 horse-power.

To obtain the full amount of motor and lighting business in buildings which now manufacture their own steam for heating, and at the same time make their own power and light, the electric company must be able to also heat the building. The electric

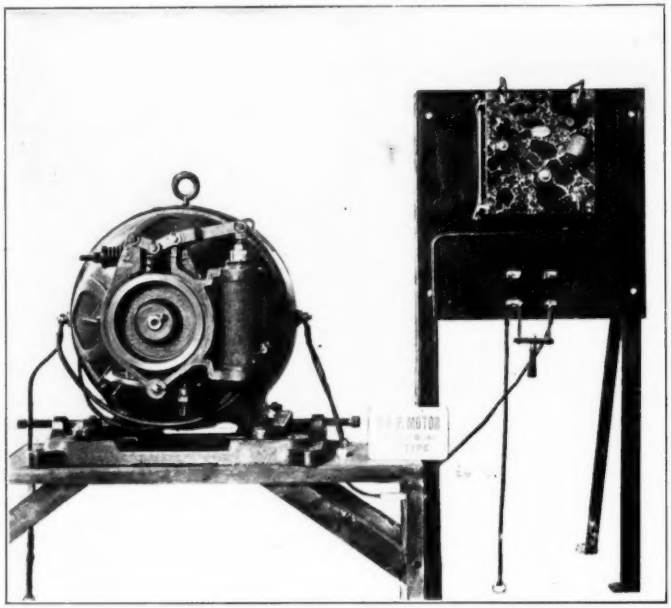
company thus equipped to supply heat holds an advantage over all competitors, whether in the form of isolated plants or competing companies.

Its business is thus placed on a more permanent footing, and consequently the company adds to the attractiveness and stability of the capital already invested.

The electric companies already sustain business relations with their prospective heating customers, all of whom would be very glad to contract with them for heating.

Many of our large manufacturing corporations depend upon their waste products for their profits. Gas companies are greatly benefited by the sale of tar, coke, ammonia, etc. Oil-refining companies make their profits largely from the by-products. Electric companies have a much more valuable by-product. The only outlay required to save this waste is that for street steam mains. Station and office expenses remain practically the same, and the income from the sale of steam is net profit.

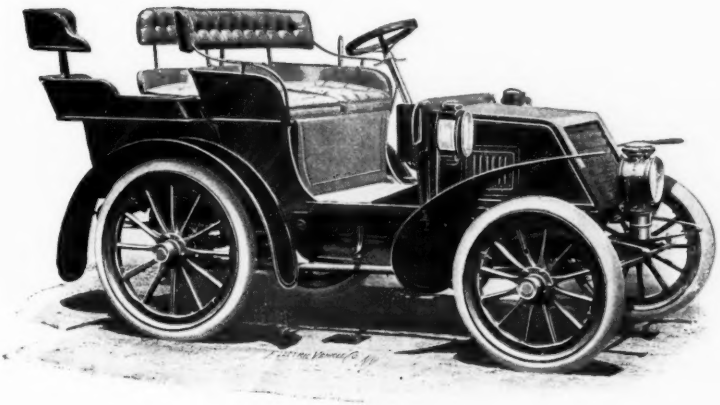
The system of district distribution for heating power offers certainly a new source of profit from the boiler plant, and is a subject worthy of investigation. The American District Steam Company, of Lockport, N. Y., are the successors to the Holly interests, controls patents and devices perfected during twenty-four years of experiments, and will give full information about the system on request. The sectional cut herewith shows the general construction of the steam main used.



CROCKER-WHEELER SOLENOID BRAKE

Crocker-Wheeler Magnetic Brake.

THE Crocker-Wheeler Company, of Ampere, N. J., have a most interesting exhibit at the Pan-American. There is exhibited, among other machines, a 30 KW 300 r. p. m. dynamos mounted on a temporary foundation. This machine has an eight pole magnet, with interval flange magnet ring. A special feature of interest is the rocker ring and brush support. The characteristics of this brush rigging are very substantial construction, means for adjusting the brushes simultaneously, and also for making permanent adjustments of each brush holder bracket independently.



RIKER TOURING CARRIAGE.

Another piece of apparatus interesting to manufacturers and users of cranes, elevators, printing presses, and similar machines requiring brakes which act instantly when the power is shut off is the Crocker-Wheeler magnetic brake, mounted on a 3½ H. P. motor, a view of which is shown herewith. This brake is extremely powerful and readily adjustable over a large range of holding power. It is operated by a solenoid, through a system of links so devised that while a powerful effort may be required to pull off the brake shoes, a very small force will hold them off, consequently, no matter how strongly the springs may be set up, the brake shoes will be held off from the brake wheels under any conditions of motor load. This feature is very valuable in crane work, where the brake solenoid is connected in series with a series motor, and where the load on the motor will vary from merely the friction load of the crane to a load corresponding to a maximum weight lifted.

Riker Touring Carriage.

THIS vehicle is equipped with a Riker vertical, double cylinder water cooled gasolene engine developing 8 H. P. at nine hundred revolutions per minute. The engine consists of two 4 x 4 cylinders attached directly to the body at its forward end, and covered by the usual form of engine bonnet. All moving parts are thoroughly protected from dust and dirt, and are easily accessible for inspection and adjustment. Enough gasolene, lubricating oil and cooling water are carried on board for a run of 150 miles under ordinary conditions. The complete weight of the vehicle with tank all full is approximately 1700 lbs.

The change gear system provides for three speeds ahead and one backward. The reductions are approximately 16 to 1, 7 to 1, and 4 to 1. Any gradation of speed between zero and the maximum can be obtained by means of the clutches and the igniter and throttle levers carried on the steering wheel spindle.

The running gear is of the standard Riker type, which presents many advantages for a high speed vehicle subject to severe road service, in that it maintains the axles in perfect alignment and the frame square at all times, at the same time relieving the body and springs of all strains other than those due entirely to the load resting directly upon them. There is a decided saving of power and wear and tear on tires as a result of maintaining the wheels in perfect rectangular alignment at all times. The wheels are mounted on ball bearings. The running friction is therefore reduced to a very low point, and extremely high speeds are possible without any danger of wheel bearing troubles.

The transmission gearing is contained in one housing, which is also slung from the body immediately in the rear of the engine,

being coupled to the engine shaft by a flexible coupling, relieving both the engine and gear shafts of any cramping due to springing of the body. The system of gearing used on this vehicle is of the friction clutch type and is entirely pedal-operated. There are two pedals located on the floor capable of being oscillated forward or backward by the toe or heel of the operator's foot.

The cooling system is of the usual type, including the pump water tank and radiating coil. The detail construction of the pump, however, is the result of a good deal of experiment and has proved reliable under all conditions. The construction of the cooling coil is so arranged that individual tubes can be readily removed and replaced in case of a leak, which is not the case with most types of cooling coil.

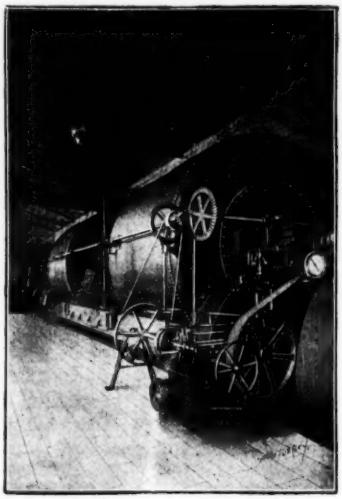
The lubrication of the entire motor is automatically taken care of from one oil valve which feeds oil into both cylinders and crank case. No attention other than the opening of this valve to a certain fixed point and keeping the oil tank full is necessary even on the longest runs. The gear case is oil tight and when once supplied with oil will run for weeks without any attention. The outboard sprocket bearings are automatically ring oiled. This leaves practically no bearing for frequent attention other than the wheels and small steering and braking lever bearings. The atomizer used on this vehicle is not of the float system. It is very much simpler, has fewer working parts, and overcomes the difficulty usually met with in the float type of atomizer on variable speed engines where the limits of variation of speed are very wide. The engine on this vehicle can be run from 200 to 2,000 revolutions per minute without any appreciable variation in the quality of the mixture obtained from the atomizer. The ignition is obtained by means of a jump-spark and permits the advancing or retarding of the point of ignition as may be desired by the operator. Primary batteries with an improved and perfected type of induction coil are used, there being two coils, one for each cylinder.

In the interests of simplicity no attempt has been made on these vehicles to time the point of ignition automatically by means of a governor, as it is true that for all ordinary running the point of ignition can be set once for all, and variations of the speed of the vehicle can be obtained by means of the throttle. For high speeds, of course, it is necessary to advance the point of ignition beyond this, so called, neutral point and the igniter lever then gives a very easy means of obtaining any desired speed.

Manufactured by the Electric Vehicle Company, New York.

Turbines Driving Mining Machinery.

THE S. Morgan Smith Co., of York, Pa., have recently installed the heaviest pair of turbines built in America. The plant consists of two 54" McCormick turbines, each mounted in a separate iron case, both discharging into one cast iron draft chest and plate steel draft tube. The power is used for operating a large air compressor and



M'CORMICK TURBINES.

generator in the power plant of the Boston & Montana Consolidated Copper & Silver Mining Co., Great Falls, Mont. The outfit weighs 300,000 lbs., not including power connections, draft tubes nor the supply pipes.

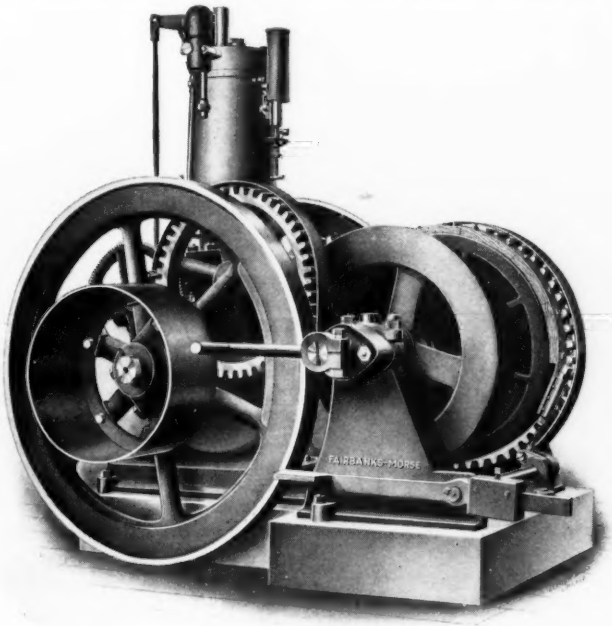
The wheels were tested at the Holyoke testing flume and gave unusually high efficiency at both part and full gate. They develop 2,600 H. P. under a head of 40 ft. The speed is controlled by a Type "B" Lombard water wheel governor. The gates

are so accurately balanced that one man operates those of both wheels with ease.

The Smith company have lately completed extensive additions to its works and now have the largest and most complete water wheel plant in the world. Parties contemplating developing water powers are requested to write them for a catalogue of the McCormick turbine.

Prospecting Hoist.

THE mining industries have long felt the want of a suitable outfit for operating a prospecting shaft; that is something aside from the cumbersome steam, or old horse power rigs.



PROSPECTING HOIST.

The gasoline geared hoist shown herewith is now offered as a substitute. Although it is comparatively light as a whole, it has been designed to sectionalize so that the largest part does not exceed 250 pounds in weight. It can therefore be taken into portions of the country not readily accessible for large and heavy machinery. When set up it forms a one-piece outfit, self contained.

The fuel for the engine is either gasoline, distillate or crude oil, one of which can usually be purchased at a very low figure in the particular locality in which the outfit would go, and as the fuel is in a liquid state it is much more easily transported, and if necessary can be delivered on mule back at a much less cost than other fuels. A few gallons of gasoline, weighing but a few pounds, will run one of these prospecting outfits for a week. The comparative cost is less than solid fuel.

No water is required save for the first filling of the cooling tank, as the same water is used continually.

The engine is fitted with a belt pulley for the purpose of driving other machinery; such as a dynamo, for operating an electric drill, a pump or the like.

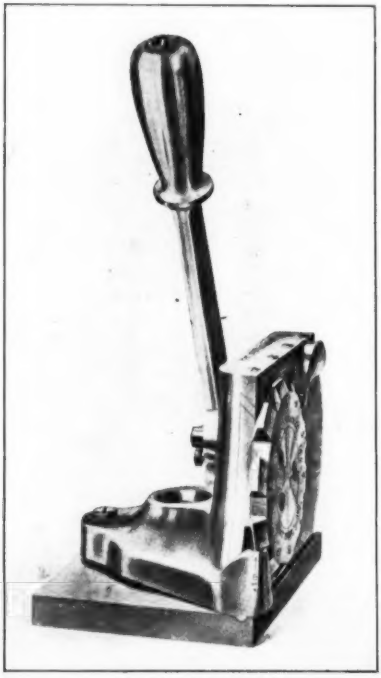
The gearing used on this combination is cut from the solid, thus making a perfect gear, with a minimum friction and the least

possible noise. The gears are so arranged that they throw out of mesh and allow the engine to be used independently when used for operating other machinery.

The hoist is fitted with a friction clutch on the drum which has a wood-filled face acting on a finished iron surface. A band brake is provided, which is also wood-filled. In fact, these hoists have all the latest improvements the same as furnished in the large outfits which Fairbanks, Morse & Co. manufacture, such as their speed controller which regulates the speed to suit the will of the operator, thus making the engine run at its minimum speed when not hoisting, attaining a great saving in the consumption of fuel. For further information regarding these and larger gasoline hoists address the makers, Fairbanks, Morse & Co., Chicago.

The Rivett-Dock Thread Tool.

It is claimed for the new thread tool shown in illustration herewith that it will turn out work from three to ten times faster than the old style tool and that the pieces are accurate and in exact duplication.



NEW THREAD TOOL.

The thread tool consists primarily of a cutter, circular in shape, mounted on a steel slide fitted to a heavy steel frame, the slide having a movement to and from the work by means of an eccentric stud in the hub of the lever, which also locks the slide when in forward or cutting position. The action of the lever moving the slide engages the cutter with the pawl, rotating it one tooth, presenting with each forward movement a new tooth or cutting tool to the work.

The heel of the tooth in action rests upon a stop, the latter taking the entire strain of the cut, so that the cutter can be ground until but an eighth of an inch in thickness and still retain the full strength and power to do the work.

The stop is adjustable to take up the small difference in height of tooth caused by grinding.

Cutters are supplied for every pitch and thread, the life being like that of taps or dies, and as a holder and set of cutters bear the same relation as a stock and set of dies; but doing infinitely finer and more accurate work, they should receive the same if not more care and attention.

The cutter is a simple disc of the best tool steel having ten teeth, each tooth being a certain increase in radial length over the preceding, presenting in its entirety ten cutting tools, the leading teeth roughing out the work in heavy, measured cuts, and the last finishing the work in precisely the same way as a single point tool.

Every part of the cutter is ground after hardening, the angle of the teeth being ground last from the flat face, so that when the face of the cutter is square with the work the thread angle is correct.

A cone washer fitting a hub on the slide, both carefully hardened and ground, secures the cutter in position, the washer being held by three hardened screws, making the firmest possible support, and every part of the tool except the cast iron shoe is made from steel forgings, carefully machined and finished all over.

To give clearance, the tops of the teeth are ground to a line five-sixteenths of an inch below center of cutter, which, when the tool is in correct position for use, is

the same distance above the center line of lathe, bringing the point of cutting tooth to the lathe center level. The angle of teeth is therefore necessarily ground slightly more obtuse than the angle of thread to be cut, which fact sometimes misleads the uninformed, as a thread gauge when held radially on the cutter does not fit the tooth, but will when held on a line crossing the face of the cutter five-sixteenths below the center.

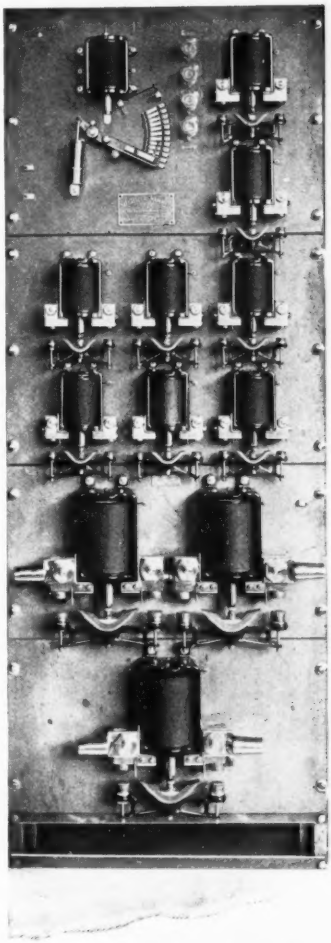
The Rivett-Dock Co., Brighton, Boston, Mass., will give full details of this most interesting tool.

Cutler-Hammer Self-Starter.

THE steady growth in the demand for appliances for automatically starting and stopping motors and the equally steady increase in the size and horse power of the apparatus to be so controlled has lead to the construction of many types of apparatus for performing these functions. The self starter illustrated herewith is one of the latest of these and contains many points of merit. It is for use with a 150 H. P. 220 volt motor driving an accumulator pump, the head being 1,500 pounds per square inch and is arranged to start or stop the motor at any desired point in the travel of the accumulator tank.

The basic principle of operation is that common to most apparatus of this type, namely, the moving of an arm over contacts by means of a solenoid. In order, however, to avoid the handling of the heavy main currents on a sliding contact and be rid of the many disadvantages incident thereto, the Cutler Hammer Mfg. Co., designers of the apparatus illustrated, have used the sliding contact to carry only the exciting currents of a set of independent solenoids which, in closing, carry the main currents of the motor over laminated contacts protected by auxiliary carbon breaks.

It will be noted that the starter in question is made up of three large independent solenoids, eight smaller ones, and a solenoid starting switch. Of the larger solenoids the one in the lower panel and that on the left of the next higher panel constitute the main circuit switch and are installed one in each leg of the main circuit. The eight smaller solenoids, and the third of the larger ones are resistance solenoids, and are arranged to cut out the resistance, step by step, the solenoid starting switch in the upper left hand corner being the actuating device. The operation of the rheostat is as follows: the falling of the accumulator tank actuates a switch—not shown—which closes the exciting circuit of the two main solenoids, causing them to close, and throw power to the motor through the resistance. The closing of the main switch also sends current to the solenoid of the actuating switch at the upper left hand corner, caus-



CUTLER-HAMMER SELF STARTER.

ing the rheostat arm to travel over the contacts, thus exciting in turn the different resistance solenoids and causing them to close and cut out the resistance, so as to bring the motor up to speed. The large solenoid at the right is the last of the independent solenoids to be excited and when it is closed the circuit to the motor is direct, the smaller solenoids being cut out of circuit and the motor across the line. On the rising of the accumulator tank to its upper limit, the before mentioned switch is opened, breaking the current to the main solenoids and causing them to drop, opening the circuit on the auxiliary carbons in an intense magnetic field and cutting the power off the actuating switch and final resistance solenoid, causing them to return to the position of starting. In order to prevent the operation of the controller out of the regular sequence, the various parts are so interlocked electrically as to prevent the reclosing of the main solenoid switch until the condition for starting has been completely re-assumed.

The advantages claimed for apparatus built in this way are, extreme reliability of operation, due to the impossibility of damage to the sliding contact by the extremely small currents necessary to excite the solenoids, the provision of ample carrying capacity where necessary, the assurance of good firm contact and avoidance of deterioration in contacts carrying heavy currents, and the ease with which accidental damage may be repaired. It will be noted in the present instance that the wiring to the motor is extremely simple, the only connections on the rheostat being for the main motor leads, the field connections, the main line connections and two small binding posts, to which the circuit wires from the small switch at the accumulator tank are connected. These latter wires are very light as the current to be handled by the switch is simply the exciting current of the two main solenoids, amounting to but one or two amperes.

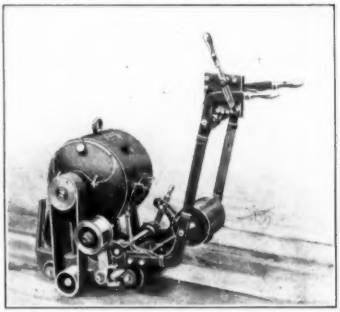
The Cutler-Hammer Mfg. Co. report having built a number of these starters in the past three months, ranging from 45 to 150 H. P. and have under construction at the present time, various others ranging from 30 H. P. to 75 H. P., and state that the reports received as to the performance of the apparatus shipped gives uniform evidence of satisfactory operation.

Portable Electric Wood Planer.

THIS machine was designed for planing decks of steamships, but it is equally useful for any large floor space which requires to be smooth planed.

The machine consists of a frame carrying the cylinder and knives and an electric motor for driving same, which is mounted on rollers and furnished with handles by which it can be pushed over the work.

The frame is made of steel to gain strength with lightness, the cutting cylinder is a steel forging in one piece, planed



ELECTRIC FLOOR PLANER.

true and slotted for the knife bolts, the knives are placed on the cylinder with one end ½" in advance of the other end so that the whole length of the knife does not cut at once but makes a drawing cut; the rollers on which the frame is mounted are turned true and fitted with hardened steel roller bearing journals, enabling the machine to be pushed easily; the back set of rollers are mounted in the frame in a swinging bracket held by an eccentric shaft, this allows the rollers to swing back and lower the knives to the work when going forward and to swing front and under lifting the knives from the work when going backward, and by adjusting a hand lever attached to the eccentric shaft the depth of the cut can be instantly changed; the power is transmitted from the motor to the cutting cylinder by a flat belt made endless, and there is a tightener and pulley to take up slack in same.

The electric motor is of the dust and water-proof type, very simple and substan-

tial in construction, and being enclosed, is well protected from the shavings and outside injury. It is furnished with a starting switch and rheostat and main line switch placed on the handles of the machine, so that all the switch levers are in easy reach of the operator's hand when in working position.

The machine can be furnished, when so desired, with an attachment to trim close up to the wall, consisting of a cutter head and shaft which is put in place of the cylinder after removing the latter, the arrangement being also fitted with a guard to keep the knives from cutting the wall.

Further details may be had from the makers, Thomas H. Dallett & Co., Twenty-third and York streets, Philadelphia.

Electric Watchman's Clock.

THE accompanying illustration is one type of the Howard electric watchman's clock, arranged for twelve watchmen.

The clock at which the watchman's record is made, can be arranged for any number of watchmen, it being limited only by the space assigned it. Any number of stations can be added or taken from the set of stations without interfering with those which remain. Any one may have free access to the interior of the clock, and still a record made in any other way than that intended will surely be detected. At the same time the cases are made in the most thorough manner, the door being set in a rabbit and secured with a Yale lock. When desired a recorder is attached to the door which prevents its being opened without making a record on the dial.

The record is a permanent one which cannot be erased, inasmuch as it is made by punctures through the recording dial, which can be preserved for future reference. This is a matter of considerable importance when considering insurance rates.

The clock may be placed in the office, or in any place near to or remote from the watchman's duties, two wires only running from the clock throughout the building, being necessary for any number of points which the watchman is required to visit on his rounds. A station is placed at every point which the watchman should visit, into which he inserts his key, which fits all stations alike, gives a turn whereupon the station automatically makes a record, and the electric currents are, by contact, allow to pass through the wire and record the specific number of each, at the moment it is visited. The record is made upon a disc of paper. It is not necessary that the stations be visited in any particular order or equal number of times, for the record of each box is given independently of any other, and the route of the watchman may be changed, and the record tells the truth of what has been done by him.

ELECTRIC WATCHMAN'S CLOCK.

It is claimed for this clock that, unlike

others, the stations give them distinctive records without reference to their locations on the receiving disc. Each station is entirely independent of the others, and the failure of any one station to respond has no effect on the working of the others. The system does not require that the watchman should be at a given point at a stated time. A watchman may claim that at a stated time he was detained at some other point in his tour, and as a proof of his statement a record from a neighboring station may be produced as proof of his veracity; but watchmen are expected to watch the premises and not the clock. This clock, however, has so little to do in locating the time of the records that the time-keeping qualities are in no way impaired: and it constitutes a time-keeper with which all offices should be equipped.

Six-inch Rule With Slide.

THIS rule is especially convenient for measuring against shoulders, width of collars, etc., and will be much appreciated by machinists. The slide can be removed and the rule used in the ordinary way, or the

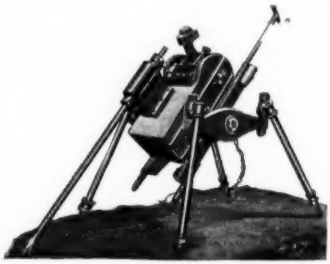
SIX-INCH RULE WITH SLIDE.

slide can be reversed to read either edge of the rule, or it can be removed and the rule used separately. The rule is 6" long, about 9/16" wide, 1/16" thick, and may be had with different graduations. Made by Brown & Sharpe Mfg. Co., Providence, R. I.

Hercules Electric Drill.

WHILE the electric current has invaded practically every other branch of mining operation its successful application to the drill has been tardy. Efforts in this direction have been centered around the general idea of producing a drill duplicating, in all mechanical essentials, the plunging blow struck by compressed air or steam machines. Wherever there has been a departure from this general plan it has been by the substitution of cam movement, obtaining a percussion blow largely by means of springs and pawls. The solenoid process had been tried and quickly abandoned, and while the combined cam and spring movement just mentioned was a decided improvement it still fell far short of obtaining the results in electric power which would make it perform its best services under all varied conditions where it should be used.

In the construction of the drill shown herewith there has been a marked departure from the types referred to. This drill, known as the Hercules, carries in the box seen in the illustration a two horse-power electric motor wound for a continuous or alternating current, according to the local requirements. This motor is geared to the drill mechanism proper by a small gear wheel engaging with the pinion of the motor precisely as is done in street car work. This intermediate gear drives the wheel shown at the right turning an axle upon which are cast two eccentrics that, revolving within their straps, raise and lower the hammer, causing it to strike a powerful blow on the head of an ordinary cross-bit drill.



As the hammer rises, the drill is automatically lifted by the plunger shown in the cut, raising the drill barrel, working in a rifled sleeve, and giving it an eighth turn and setting it firmly on the stone before the blow is delivered.

With less than two horse-power more than 200 blows a minute can be struck, the force of the blow depending, of course, on the speed, as the more rapid the blow the harder it is. The speed is regulated by an ordinary starting box attached to the machine and within easy reach of the operator. All wearing parts work upon ball bearings and are made dust and water-proof.

A test made of the force of the blow, and using a seven-pound hammer at a speed of 200 blows per minute showed that the blow was equivalent to fourteen tons hydraulic

pressure, yet so easy is the movement of the mechanism that one of those ordinary drills weighing less than 400 pounds, will stand on four legs and do its work without twist or vibration sufficient to interfere with the free movement of the drill in the hole.

Among the advantages claimed for the Hercules drill may be mentioned: (1) The movement is essentially an eccentric movement, unaided by springs, pawls, or similar mechanical devices; (2) it strikes a direct axial percussion blow squarely on the head of the drill placed in whatever position it is desired to drive a hole in the rock: (3) all parts of the machine are interchangeable, so that in the event of breakage repairs can be made without taking the machine from its place of work or calling in a blacksmith; (4) The blow is infinitely more powerful and direct, and all strains are reduced to a minimum; (5) that it will cut rock faster and work equally well in deep as in shallow holes; (6) low cost of installation.

Fuller details may be had from the Hercules Electric Drill Co., 32 Broadway, New York.

Prevention of Smoke.

THE Smoke Prevention Co., of 66 Broadway, New York, have developed an interesting system for the prevention of smoke with soft coal. The materials used by them are necessarily the materials used by Nature to effect her work, but their system of controlling the gases generated from this coal is new and in thorough accord with the demands of science along this line.

Their way of preventing smoke is to force into the fire at the time the hydro and free carbons are being liberated from the coal, sufficient oxygen to ignite these carbons, thus making them into valuable heat units instead of allowing them to escape unconsumed in columns of smoke.

Without this excess of air, the gases from the coal are of course uninflammable. The peculiar merit of the device of this company is its arrangement for thoroughly intermixing the oxygen of the air with the gases of the coal before they have become smoke. It is, therefore, a system of smoke prevention and not, as is usual in this class of devices, an arrangement for "consuming" smoke after it is once made. It is claimed by this company that "consumption" cannot be economically accomplished, for the carbons which have become solidified, forming smoke, must be again gasified before any consumption can be effected.

Their system consists of a patented fire brick tiling, which is put in the lining of the fire box just above the grate. These tiles weigh about sixty pounds and are made of the finest quality of fire brick. They extend from a point below the grate to one about ten inches above.

These tiles contain chambers allowing for the passage of air from the ash-pit to a point above the fire bed. When fresh coal is thrown on the fire, the opening of the door automatically starts a device for forcing columns of air, heated in the ash-pit and in the air chambers behind the tiling, into the furnace chamber at the precise moment when needed to perfect the combustion.

The air enters the furnace from either side though the air channels in jets which strike each other, mixing completely with the free carbons, making a perfect combustion and creating a centrifugal motion over the bed of the fire, which prevents cold air from entering the flues or striking the heat absorbing surface. The combustion of all of the carbons of the coal is thus effected and at the same time the temperature of the gases in the combustion chamber is maintained while stoking.

It is claimed for this device that it is positive in its action and easily regulated to suit any kind of coal. It works entirely automatically and closes off gradually as the free carbons are ignited and the coal is coked. The combustion of all of the free carbons under the boiler as fuel, instead of wasting them as smoke, gives this device an unequalled advantage in the economical consumption of coal. The amount of this saving, of course, is governed by the conditions surrounding each plant, varying from ten to forty per cent., the higher percentages being the result of improvements in the furnace and also from the substitution of cheaper fuel.

This company claims to be the only concern in the world which makes a scientific study of each plant separately, by competent experts on combustion, in order to realize the highest possible efficiency in ev-

ery case. This company has been doing business under its present management since the 1st of January and is already recognized as having the one practical smoke preventing device that is successful in daily and continual practice.

Industrial Notes.

MR. G. V. FLYNN, who has been connected with the New York sales office of the Westinghouse Electric & Manufacturing Company, has resigned to embark in the electrical contracting business. Mr. Flynn has had an extensive experience covering twelve years in the electrical field. He has associated with him Mr. H. J. Reilly, Jr., who is well known in the business circles of New York. They have opened offices and warerooms at 72 and 74 Trinity Place, Manhattan, under the firm name of G. V. Flynn & Co., and are prepared to handle all kinds of electrical contracts, making a specialty of the equipment of isolated plants.

The display of the International Correspondence Schools at the Pan-American Exposition, Buffalo, has been completed, and compares very favorably with the surrounding exhibits of other educational institutions. It is situated in the northeast corner of the Liberal Arts Building, where an enclosure has been erected for all educational work.

The exhibit occupies what is termed three units; that is, three cases against the high board partition furnished by the exhibition people to the various exhibitors. The lower part of the cases contains complete sets of bound volumes, above which are arranged three cases containing about 100 cards on which are mounted samples of students' drawing plates, photographs of the different departments of the schools, and practical examples of students' instruction papers and original designs executed after studying their courses. The electrical outfit, drawing outfit, and blowpipe outfit form conspicuous features of the arrangement.

Charles A. Schieren & Co., of New York, have an attractive showing of tanners' and leather belting in Machinery Hall at Buffalo. Their booth is oriental in design, and is ornamented with handsome gold signs. An attractive feature is the wainscoting of leather. All kinds of belting are displayed, and one length measures 169 feet. There is a 72-inch three-ply belt that has been sold to the People's Tramway Company, of Danielsonville, Conn., and will be used for hydraulic power purposes. This belt has been colored black by the application of a dressing which the makers apply to certain grades of belting. A feature of this belt is the American joint, which causes the belt to hug the pulley.

The Chicago Pneumatic Tool Co. has received through its foreign office the largest single order for pneumatic tools ever placed with them, and probably the largest ever placed in the world, consisting of fifteen hundred and twenty-five tools, as follows: 275 Boyer long stroke hammers; 750 No. 1 chipping and calking hammers; 25 No. 000 extension riveters; 25 No. 000 yoke riveters; 25 1¾" x 6" yoke riveters; 400 Boyer drills; and 25 No. 4 Chicago breast drills.

The Sprague Electric Company have recently closed an interesting order for generators to be direct connected to gas engines. These machines, three in number, of 500 K. W. capacity each, will be installed in the new works of the Lackawanna Iron & Steel Co., at Buffalo. The gas engines are to run at a speed of 100 r. p. m. and will utilize as fuel waste gas from the coke ovens of this company. These will probably be much the largest generators in this country ever operated by direct connected gas engines, and the method of utilizing waste gases for such large amounts of power has never before been attempted in the United States. The generators are of the Lundell split pole type, and are designed for a continuous overload of 25 per cent.

The New Process Raw Hide Co., Syracuse, N. Y., has received a contract from the United States Mint at Philadelphia for six "New Process" noiseless pinions 16" diameter, 6" face. These pinions are a part of the equipment of the new mint building, the machinery for which is just being installed. They are to be used for transmitting power from a 50 horse-power motor to a 10" x 9" rolling mill and will run 175 r. m. p., meshing into a 60" iron gear. Six armature pinions for the same motors were shipped by the company a short time

ago. They are 12 2/3" diameter, 4" face, and will run at the speed of 525 r. p. m. The company has just made a shipment of twenty-four pinions to the Sao Paulo Lt. & Traction Co., Sao Paulo, Brazil.

The American Diamond Rock Drill Co., of New York, have recently shipped to Spain seven of their drills, ranging from large machines of 3,000 feet capacity to small drills with capacity of 400 feet depth. The intermediate drills of from 1,000 to 1,500 feet capacity on these orders were furnished mounted with boilers and pumps on special carriages, making complete portable rigs. Mr. Chas. Garvey, who has been employed by the above company for a number of years as an expert in the operation of diamond drills, has sailed for Spain to take general charge of all these machines. Other recent shipments of their machines have been made to Mexico, British Columbia, Alaska, Cuba, and the Philippine Islands, as well as to various parts of the United States.

One of the interesting exhibits at the Pan-American Exposition is the tastefully decorated booth of the E. Howard Clock Co., Boston and New York, in which are exhibited a working model of a tower clock equipped with a four ft. illuminated dial and 400 lb. bell on which the hours are struck. They also have on exhibition the largest tower clock that has ever been constructed, capable of driving the hands to four dials each measuring 40 ft. in diameter and constructed to bring the full tone out of a bell weighing 12,000 lbs. Besides the above, they show in full operation their watchman's clock system. A notable feature of their exhibit is a fine regulator, which electrically controls several secondary clocks placed in different parts of the booth. This is a feature of the Howard company's business which is largely on the increase, as a system of uniform time, in the different rooms of any large building is greatly to be desired, and this can be accomplished by having a master controlling clock, which operates any quantity of dummy or secondary clocks.

The Cleveland Pneumatic Tool Company have opened a New York office at 15 Cortlandt street, in charge of Mr. W. F. McGuire, where samples of their complete line of chipping, beading and caulking hammers, Cleveland long stroke riveting hammers, piston, rotary and breast drills can be seen.

In Block No. 26 of Machinery Hall is an exhibit of heaters, fans, engines, blowers, dry-kilns, trucks, and other kindred machinery by the American Blower Co., of Detroit, Mich., which is quite interesting and well worth the few minutes time necessary to inspect it by any one who has use for such machinery. The booth this company has put up is one of the handsomest in the building. The general scheme is rendered in ivory white and deep green. This feature is some 20 feet in heighth, being topped by a gable-end resting on some very prominent columns. Above same is a large painting nearly 60 feet in heighth designed to be somewhat emblematical of the American blower. The company has another feature which attracts a great deal of attention, being a model of their widely known and very successful "Moist-Air" Dry Kiln. This model has a glass side, enabling the spectator to see the exact operation of the kiln. They also have a large 140" fullhouse steel plate fan running, being driven by an 8 x 6 marine type vertical engine, coupled direct to the fan shaft. From the discharge of this fan, which points upward, they have many yellow and blue ribbons streaming up into the air. In the wall back of the exhibit they have fitted a 108" disc fan, which is about as large as one commonly sees in such a place. It is by no means the largest they build, however. They are also exhibiting a Moorehead automatic return steam trap in operation, which clearly shows how the trap drains condensation from heating surfaces and delivers it direct to the boiler. There is also a large pressure blower mounted on a Z iron base, on the other end of which is the vertical automatic high-speed engine for driving same. They are also showing a horizontal, automatic high-speed engine and a vertical low-pressure engine, as well as the A, B, C exhaust fans.

Mr. Frederick Brotherhood has been appointed manager of the foreign sales department of the Railroad Supply Company, with headquarters at their New York store, 106 Liberty street.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue B, showing an extensive line of air compressors actuated by steam, gearing, electricity, water power, etc., suitable for operating pneumatic tools in shops, foundries, and shipyards; mining and quarrying machinery; sinking caissons, and pumping. Size, 48 pages, 7 by 9 inches. New York Air Compressor Co., 95 Liberty St., New York.

Automobiles.

General descriptive catalogue of Columbia gasoline runabouts. A very full description is given, with details of parts. Size, 16 pages and plates, 5 by 9 inches. Electric Vehicle Co., 100 Broadway, New York.

Ball Bearings.

Circulars Nos. 20, 21, 24, and 26, supplementing catalogue, and showing a line of ball bearings of many styles for machine tools and special machinery. Size, 20 pages, 4½ by 7 inches. Ball Bearing Co., Watson St., Boston, Mass.

Bolts, Screws, Nuts, etc.

Catalogue No. 114, presenting a complete line of bolts, screws, nuts, supplies, etc. Goods are sold direct to the customer and not through the trade. Size, 100 pages, 5½ by 7½ inches. Hammacher, Schlemmer & Co., New York.

Coupler.

Catalogue showing the Westinghouse automatic air and steam coupler for coupling and uncoupling the air brake and steam hose of a train without going between the cars. Size, 26 pages, 6 by 9 inches. Westinghouse Automatic Air & Steam Coupler Co., St. Louis, Mo.

Dynamos and Motors.

Souvenir pamphlet in commemoration of the Pan-American Exposition, showing the principal styles of Bullock generators and motors. Size, 16 pages, 3½ by 6 inches. Illuminated cover. Bullock Electric Mfg. Co., Cincinnati, Ohio.

Synopsis of the S. K. C. system of alternating current generators, transformers, switchboard apparatus, etc. Size, 20 pages, 3½ by 6 inches. Stanley Electric Mfg. Co., Pittsfield, Mass.

Feed Water Filter.

Fully illustrated pamphlet of Rankine's feed water filters for land and marine boilers. Special types are made for electric lighting plants, factories, mills, etc. Size, 20 pages, 7½ by 8½ inches. W. Blackburn Smith, Perth Amboy, N. J.

Steam Turbine.

Catalogue describing in detail, with illustrations and data, the various types of the De Laval steam turbine. Size, 60 pages, 5 by 7 inches, with folding plate. De Laval Steam Turbine Co., New York.

Pipe Covering.

Pamphlet describing "Asbestocel" sectional pipe covering, composed of pure asbestos paper, corrugated and formed into cylindrical sections, fitting all standard wrought iron pipe. Size, 8 pages, 3½ by 5½ inches. H. W. Johns Mfg. Co., New York.

Milling Machines.

New catalogue showing many improvements in milling machines, notably in the feed mechanism. Size, 20 pages, 6 by 9 inches. Cincinnati Milling Machine Co., Cincinnati, Ohio.

Catalogue E, showing a very full line of milling and boring machines of somewhat different design from those usually made. Handsome engravings and explicit text make this catalogue valuable. Size, 90 pages, 6 by 9 inches. The Beaman & Smith Co., Providence, R. I.

Oiling Devices.

Small illustrated catalogue, presenting a list of oiling devices and dust proof oil hole covers, substituting open oil holes, loose plugs, screws, etc. Size, 16 pages, 3½ by 6 inches. The Winkley Co., Hartford, Conn.

GENERAL LIBRARY
AUG 31 1901

25 CTS.: $3.00 A YEAR.

THE ENGINEER MAGAZINE

AN INTERNATIONAL REVIEW

EDITED BY JOHN R. DUNLAP
CHARLES B. GOING, AND HENRY HARRISON SUPLEE.

ENGINEERING AT THE GLASGOW EXHIBITION—
Salient Points in the Steam-Plant and Machinery Section — Dr. John G. Kerr — 817
MECHANICAL AND ELECTRICAL FEATURES OF THE BUFFALO EXPOSITION—
Dominant Tendencies and Important Appliances Displayed
THE ENGINEERING ORGANIZATION OF A GREAT EXPOSITION
An Example of Works Management on a Colossal Scale
AMERICAN MACHINE-SHOP PRACTICE FROM A GERMAN VIEW
Characteristics of Equipment, Organization and Labor
ELECTRIC-POWER DISTRIBUTION SYSTEMS FOR FACTORIES—
Direct vs. Alternating Current, and the Best Voltage
THE GOLD-MINING POSSIBILITIES OF SIBERIA—
Primitive Methods in a Region Rich as the Transvaal
PROPER DISTRIBUTION OF THE FACTORY EXPENSE BURDEN—
The Scientific Machine Rate and the Supplementary Rate
THE WATER-TUBE BOILER FOR MARINE INSTALLATIONS—
Its Adaptability to Large Units and Emergency Service

REVIEW OF THE ENGINEERING PRESS

The British Press, 921 — The Continental Press, 929 — ... — 937

THE ENGINEERING INDEX

With Descriptive Notes Clearly Indicating the Character and Purport of the Articles in the Technical Press of Great Britain, the Continent

CIVIL ENGINEERING, - - - - - - - 947
ECONOMICS AND INDUSTRY - - - - - - 952
ELECTRICAL ENGINEERING, - - - - - - 951
GAS ENGINEERING, - - - - - - - - 958
MARINE ... - - - 959
MECHANICA... - - 960
MINING AN...
RAILWAYS ...

PUBLICATION OFFICES, 120-122 LIB...
222-225, STRAND, LOND...

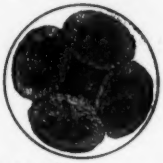
MONTREAL 206 St. James St. | MELBOURNE Sun Buildings. | JOHANNESBURG Goodman & Co. | CAPETOWN 33 Loop St.
PARIS 22 Rue de la Banque. | ST. PETERSBURG 14 Nevsky Prospect. | BERLIN 5 Unter den Linden.

THE..

AMERICAN MANUFACTURING CO.,

63 Wall Street, New York.

TRANSMISSION ROPE MAKERS.

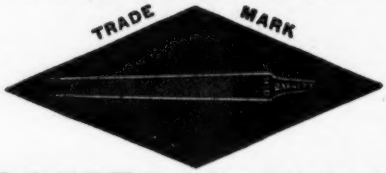


Section showing application of plumbago.

Send for "A Little Blue Book on Rope Transmission."

BLACK DIAMOND FILE WORKS.

Twelve Medals of Award at International Exhibitions.



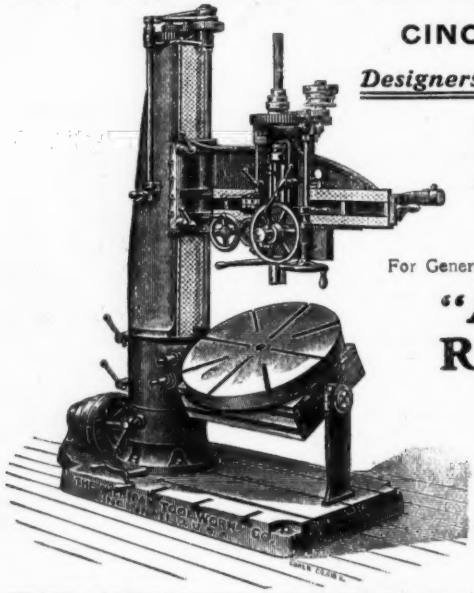
Special Prize, GOLD MEDAL, at Atlanta, Ga., 1895.

G. & H. BARNETT CO., Philadelphia, Pa.

The American Tool Works Company,

CINCINNATI, U. S. A.,

Designers and Builders of



Machine Tools.

For General Manufacturing the

"American" Radial Drill.

HAS NO EQUAL.

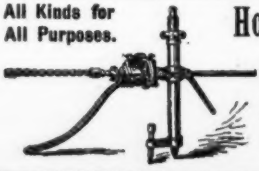
This Drill can be seen in operation at our Exhibit, Section 39, Machinery Hall,

Pan-American Exposition,

Buffalo, N. Y.

ESTABLISHED 1876

All Kinds for All Purposes.



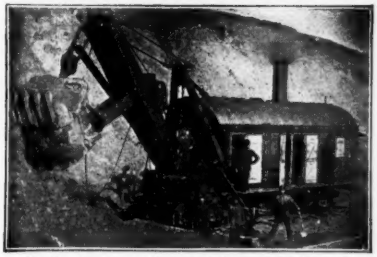
Howells Mining Drill Co., Plymouth, Pa.,

Manufacturers of Drills for nearly every class of work. For boring Rock, Coal, Slate, Fire Clay, Gypsum, Soap-Stone, Plaster Rock, Rock Salt, etc. Our No. 2 Air Drills will drill 6 ft. per minute in coal and all other soft material.

SEND FOR CATALOGS.

Copyrighted, 1901, by John R. Dunlap. Entered at the New York Post Office as mail matter of the second-class.

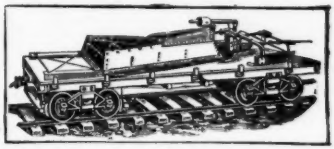
KEARSARGE
ASBESTO-METALLIC GASKETS.
SHEET & PISTON ROD PACKINGS for HIGH PRESSURE & HIGH SPEED ENGINES &c.
FLEXIBLE · STRONG · DURABLE
ASBESTOS
BOILER & PIPE COVERINGS.
THE PERFECT NON-HEAT CONDUCTORS.
H.W. JOHNS MFG CO.
NEW YORK · BOSTON · PHILADELPHIA · CHICAGO



Particulars regarding machinery suitable to your needs, and illustrated catalogues gladly sent.

Address The Marion Steam Shovel Co., No. 607 W. Center Street, MARION, OHIO.

The Marion Steam Shovel Co.
MARION, OHIO,
Manufacturers of a full line of
Steam Shovels, Ballast Unloaders, Dredgers and Ditchers,
Suitable for all Classes of Work.

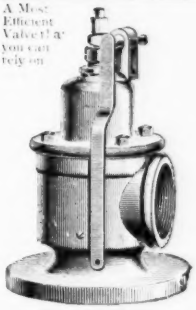


A Truth'nl Gage is the only good Gage.

CROSBY

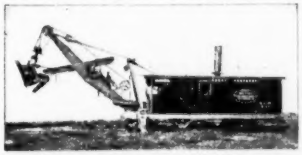
STEAM ENGINE INDICATORS.
PRESSURE AND VACUUM GAGES.
STATIONARY AND MARINE VALVES.
WATER RELIEF VALVES.
RECORDING GAGES.
REVOLUTION COUNTERS.
LUBRICATORS AND OIL CUPS.
SINGLE BELL CHIME WHISTLES.
BRANDEN RUBBER PUMP VALVE.
JOHNSTONE BLOW-OFF VALVES.
FEED WATER REGULATORS, ETC., ETC.

A Most Efficient Valve that you can rely on



Pop Safety Valve

CROSBY STEAM GAGE & VALVE CO.,
OFFICE AND WORKS, BOSTON, MASS.
STOKES—03-07 Oliver St., Boston. 78 John St., New York. 21-23 Lake St., Chicago. 75, Queen Victoria St., London, England.



THE BUCYRUS COMPANY,
DES'GNERS AND BUILDERS OF
Dredges, Steam Shovels, Excavating Machinery, Steam, Electric, and Locomotive Cranes, Centrifugal Pumps, with Simple, Compound or Triple Expansion Engines, Pile Drivers, Wrecking Cars, Placer Mining Machines.
SOUTH MILWAUKEE, WIS.

AIR COMPRESSORS For every application of compressed air power.
COMPRESSED AIR TOOLS and APPLIANCES
CLAYTON AIR LIFT PUMPING SYSTEM
Clayton Air Compressor Works,
Complete catalogue sent upon application.
26 Cortlandt Street, New York.
Please mention The Engineering Magazine when you write.

THE MACHINERY EXHIBIT OF....

The Philadelphia Bourse.

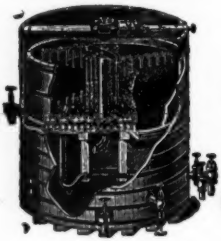
The Only Place in the United States

where the leading makes of machinery can be seen side by side in operation, making it easy for the purchaser to select the makes best suited to his needs. All machinery manufacturers should be represented in the Machinery Exhibit of the Bourse, where they come in contact with buyers from all parts of the world.

ADDRESS:

THE BOURSE,

PHILADELPHIA.



Gravity and Pressure Filters

CONSTRUCTED UNDER THE

Jewell, Warren and Hyatt Patents,

The Acknowledged Standard of Mechanical Filtration.

HIGHEST EFFICIENCY. LOWEST PRICE.

Adopted by 148 City and Town Water-Works in the United States.

NEW YORK CONTINENTAL JEWELL FILTRATION CO.,

15 BROAD STREET, New York. 40-42 WEST QUINCY STREET, Chicago, Ill.

FUEL GAS PLANTS FOR FACTORIES.

COMPLETE INSTALLATION, INCLUDING

GAS BLAST FURNACES FOR ANY KIND OF WORK.

THOROUGH EFFICIENCY, ECONOMY AND SAFETY WARRANTED.

Descriptive Pamphlets on application to

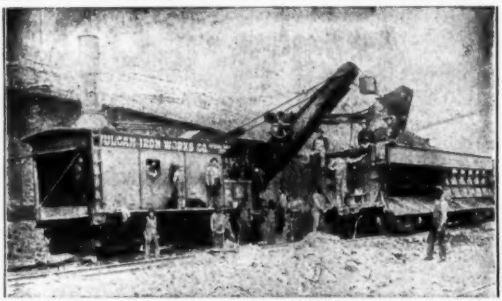
AMERICAN GAS FURNACE CO., - - 23 JOHN STREET, NEW YORK.

AN ERICSSON?

Yes, and "UNCLE SAM" uses them.

WE CAN HELP YOU. Used in Shops, Factories, Offices, etc., etc. PARTICULARS FREE.

Ericsson Telephone Co., - - 296 Broadway, N.Y. City.



"Boom" Steam Shovels and Dredges.

Cut shows 50 ton "BOOM" Shovel at work on Norfolk & Western Railway.

Vulcan Iron Works Co.

TOLEDO, OHIO, U. S. A.

THE PUBLISHER'S ANNOUNCEMENT.

Subscription price, $3.00 (or 12 s. 6 d.) a year, in advance. Booksellers and Postmasters receive subscriptions. Subscribers may remit in Postoffice or express money-orders or in bank checks, drafts, or registered letters, made payable to "THE ENGINEERING MAGAZINE." Money in letters is at sender's risk.

SPECIAL NOTICE:—The date to which each subscription has been paid appears, with the address, on the wrapper enclosing each number of the Magazine. The publisher must be notified by letter when a subscriber wishes his Magazine discontinued. All arrearages must be paid.

PUBLISHED MONTHLY.

THE ENGINEERING MAGAZINE,
120-122 Liberty Street, New York, U. S. A.

AUTHORS AND PAPERS FOR SEPTEMBER, 1901.

JOHN GUTHRIE KERR, M. A., LL. D. *(Engineering at the Glasgow Exhibition)*—Headmaster of Allan Glen's School, Glasgow, one of the most noteworthy of the "Schools of Science" in Britain. Dr. Kerr is an Ayrshire man; he was a distinguished student at the Universities of Glasgow and Oxford, and at the Royal College of Science, London; he has devoted much attention to the problems of training for practical life, and two years ago he received from his alma mater the degree of Doctor of Laws for services to education, particularly in connection with physics and laboratory work. Dr. Kerr is a member of the Executive of the 1901 Glasgow Exhibition, and is mainly responsible for that section of the Exhibition which deals with schools. His article in this number is the result of a special study made for this Magazine.

WILLIAM S. ALDRICH *(Mechanical and Electrical Features of the Buffalo Exposition)*—Graduate United States Naval Academy, 1883; mechanical engineer, Stevens Institute of Technology, 1884; experience in shops and drawing rooms of Ball Engine Company and William A. Harris Steam Engine Company; in drawing rooms of Baldwin Locomotive Works and I. P. Morris Company, and engaged at various times in engineering, design, and construction of patented mechanical and electrical specialties, and in testing electric railway, cable, and pumping plants; instructor in drawing and later associate in mechanical engineering, Johns Hopkins University, department of electrical engineering, 1889-92; head of department of mechanical engineering, West Virginia University, 1893-99; volunteered for service in the engineer corps of the United States Navy at breaking out of the Spanish-American war, and, after examination, was appointed passed assistant engineer, United States Navy, with rank of lieutenant, and assigned to duty on the U. S. S. Vulcan, on which vessel he served till honourably discharged from the naval service. At present in independent practice as consulting engineer.

PERCIVAL ROBERT MOSES *(Electric-Power Distribution Systems for Factories)*—Born in New York; educated in Europe and the United States; entered School of Mines, Columbia College, N. Y., 1891; graduated in 1895-1896, with degree of electrical engineer; with Sprague Elevator Company in factory and construction work; now practicing as consulting engineer; associate member of the American Institute of Electrical Engineers.

CHESTER WELLS PURINGTON *(The Gold-Mining Possibilities of Siberia)*—Born in Boston, Mass., 1871; graduated Harvard College, 1893; until 1897 served on the mining staff of the U. S. Geological Survey in Alaska and Colorado, and is author of U. S. Government report on the mining industries of Telluride, Colorado, and joint author with Mr. Whitman Cross of geological reports on Telluride and the La Plata mountains, Colorado. Since 1897 has been engaged in examining gold properties for private corporations, in Siberia, the Guianas, and various parts of the United States, and has made four separate professional journeys of this character to Siberia. Mem-

DURABLE WIRE ROPE

Made of the Finest Selected Steel.
Each Strand served with American Hemp Marlin.

HAS NO EQUAL FOR ROPE TRANSMISSION.

Good points of regular wire rope retained. Weak points overcome. Good qualities of hemp rope incorporated. A perfect wire rope. The very best and cheapest rope on the market, combining

Strength, Flexibility, Freedom from Rust, and Durability.
For Transmission, Hoisting, Elevators, Rigging, Etc.

DURABLE WIRE ROPE CO., - - - No. 294 Congress St., Boston.

Please mention The Engineering Magazine when you write.

ber of the American Institute of Mining Engineers, and contributor to the transactions of that body. Present address, Silverton, Col, U. S. A.

A. HAMILTON CHURCH *(The Proper Distribution of the Factory Expense Burden)*—Born near London, 1868, of Anglo-American parentage, and educated at Twickenham; joined the electrical staff of the National Telephone Co. and gained subsequent manufacturing experience in Birmingham; re-entered the Telephone Co.'s service, opening and organising their works at Aston; later was assistant to Mr. Slater Lewis (author of "Commercial Organisation of Factories"), and subsequently secretary of limited companies, London and Manchester; now practising as an expert in the organisation of factories and engineering works. Honours medallist, telegraph engineering; is a writer on social questions. The article in this issue is the second of a series of six setting forth a new and interesting system of cost keeping.

JOHN PLATT *(The Water-Tube Boiler for Marine Installations)*—Born June 1, 1864, in Gloucester, England; son of the late Mr. James Platt, the well-known hydraulic engineer; took the engineering course under Prof. A. B. W. Kennedy at University College, London, in 1884; practiced as a consulting engineer, and was with the firm of Fielding & Platt, Ltd.; is now a member of the firm of Thorpe, Platt & Co., mechanical engineers, the American representatives of John I. Thornycroft & Co. For some years has taken a great interest in the marine water-tube boiler question. Associate member Institute of Civil Engineers; associate of the American Society of Naval Engineers.

GEORGES CAYE *(The Engineering Organisation of a Great Exposition)*—Born in Paris, 1869; educated at the Ecole Nationale des Ponts et Chaussées, as civil engineer; attached in 1895 to the department of technical research of the Direction of Agricultural Hydraulics, under the Minister of Agriculture. A contributor to "La Nature," "La Vie Scientifique," and other important reviews in France and abroad, upon matters of technical interest. Author of an important treatise upon industrial mechanics.

PETER WILHELM LÜDERS *(American Machine-Shop Practice from a German View-Point)*—A German engineer especially well versed in machine-shop practice at home, in England, and in the United States, having been sent in connection with official investigations upon foreign competition to visit the works of England and America, and having studied the methods of both countries on the spot. Member of the firm of Henry Pels & Co., Berlin, handling machinery and foundry supplies, Associate Member of the American Society of Mechanical Engineers.

15,000,000 BARRELS

"HOFFMAN" CEMENT

Have Been Used on Important Work

THROUGHOUT THE UNITED STATES.

NO OTHER CEMENT COMPANY CAN SHOW SUCH A RECORD

THE LAWRENCE CEMENT COMPANY,

Established 1853.

E. R. ACKERMAN, Pres.....Assoc. Am. Soc. C. E.

SALES OFFICE: NO. 1 BROADWAY, NEW YORK.

ATLAS PORTLAND CEMENT.

IS THE STANDARD AMERICAN BRAND.

A few of the many Engineers who are large users of Atlas Portland Cement.

Chas. Sooysmith, New York.
Alfred P. Boller, New York.
Thos. C. Clark, New York.
George S. Greene, Eng.-in-Chief of New York Department of Docks.
Walter Katte, Chief Engineer N. Y. C. & H. R. R. R.
Maj. W. H. Marshall, U. S. Engineer, Chicago, Ill.
William B. Parsons, New York.
T. T. Johnston, Assistant Chief Engineer Sanitary District, Chicago, Ill.
Geo. H. Benzenberg, City Engineer and President Board of Public Works, Milwaukee, Wis.
John T. Stevens, Chief Engineer Great Northern R. R.
Wilkins & Davison, Civil Engineers, Pittsburg, Pa.
B. J. T. Juep, City Engineer, Indianapolis, Ind.
M. L. Holman, Water Commissioner, St. Louis, Mo.
A. L. Milner, Street Commissioner, St. Louis, Mo.
A. H. French, Brookline, Mass.
William Jackson, Boston, Mass.
Earnest Adam, City Engineer, Newark, N. J.

ATLAS PORTLAND CEMENT CO., 143 Liberty Street, New York.

IMPROVED TRANSITS AND LEVELS.

220 p. illustrated Catalogue mailed free ONLY if this ad. is mentioned.

Graduated entirely on our large divided engines. Special award at World's Fair. All kinds of Engineering, Surveying and Drafting instruments and materials.

QUEEN & CO., Inc.,

N. Y. OFFICE, 116 FULTON ST., **PHILADELPHIA.**

Dixon's Pure Flake Graphite

IS A BLESSING TO EVERY ENGINE ROOM AND MACHINE SHOP.

A small quantity added to any Oil or Grease largely increases its lubricating value and makes the finest Cooling Mixture.

PAMPHLET AND SAMPLE SENT FREE.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J.

ASHTON POP SAFETY VALVES, STEAM GAGES

AND HIGH GRADE ENGINE AND BOILER FITTINGS.

Unequalled for Efficiency and Durability.
Guaranteed Satisfactory on High Pressures.

SPECIAL FITTINGS FOR STEAM VEHICLES.

Write for Catalogue "D."

THE ASHTON VALVE COMPANY,

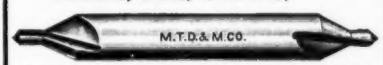
271 FRANKLIN STREET, - - - - BOSTON, MASS., U. S. A.
BRANCHES: New York. Chicago. 1 and 2 Rangoon St., London, E. C., England.

Morse Twist Drill & Machine Co.,

NEW BEDFORD, MASS., U. S. A.,

MANUFACTURERS OF

ARBORS, CHUCKS, COUNTERBORES, COUNTERSINKS, DRILLS, DIES, GAUGES,



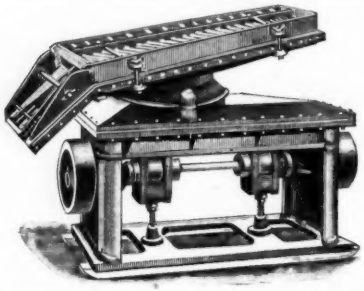
MANDRELS, MILLING CUTTERS, MILLS, TAPER PINS, REAMERS, SCREW PLATES, SOCKETS, SLEEVES, SLITTING SAWS, TAPS AND TAP WRENCHES.

Walworth High Pressure Valves, Fittings and Bent Pipe.

Brass and Iron Goods and Tools

WALWORTH MFG. CO.,
128-136 Federal St., BOSTON, MASS.

Please mention The Engineering Magazine when you write.



The Age of Concentration . . .
The Concentrator of the Age.

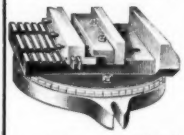
The Hooper Pneumatic Concentrator accomplishes the results heretofore possible only when water was available by the use of air under pressure. It is especially adapted to arid districts or great altitudes. . . . . .

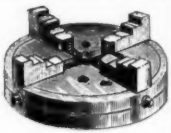
Some have WATER but all have AIR.

If you are interested write us.

GENERAL CONCENTRATES CO.,
128 Broadway, New York.
Testing Plant, - - 517 W. 30th Street, N. Y.

SKINNER CHUCKS,





FOR **Lathes, Drills, Planers.**

6 in. x 9 in. Illustrated Catalogue Free.

THE SKINNER CHUCK CO.,
NEW BRITAIN, CONN., U. S. A.

U. S. METALLIC PACKING CO.,
PHILADELPHIA, PA.
Locomotive, Stationary and Marine
PACKING.
120,000 Sets in Use. Prices Low. Service Long.
SILVER MEDAL AWARDED, PARIS, 1900.

Consult the Engineering Index in this Number.

Rockwell-Wabash Expansion Business Systems.

SYSTEM.....

points the path

TO SUCCESS

and the

Rockwell-Wabash

Expansion Business *Systems* help to turn prospects into profits.

They combine all features of Standard Filing Cabinets, including Card Index Cabinets, Letter Files, Document Files, Catalog Files, Pigeon Hole Cases, Legal Blanks, etc. Send for Catalog.

Rockwell & Rupel Company,
CHICAGO, U. S. A.

Building a *Sectional* Stack.

Please mention The Engineering Magazine when you write.

A Buyers' Directory of
THE ENGINEERING AND MACHINERY TRADES

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index on page 23.

Acetylene Generators.
Power Specialty Co., 126 Liberty St., New York.

Acid Works Castings.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Advertising.
Manufacturers' Advertising Bureau (Benj. R. Western), 126 Liberty St., New York.

Air and Gas Compressors.
Allis-Chalmers Co., Chicago, Ill.
American Engineering Works, Chicago, Ill.
American Well Works, Aurora, Ill.
A. H. Barber Mfg. Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York
E. A. Blanton, Jr., Philadelphia, Pa.
Clayton Air-Compress. Wks., 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Hall Steam Pump Co., Pittsburg, Pa.
Holly Mfg. Co., 120 Liberty St., New York.
Ingersoll-Sergeant Drill Co 26 Cortlandt St., New York.
Jacobson Machine Mfg. Co., Warren, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
McKiernan Drill Co., 120 Liberty St., New York.
Norwalk Iron Works, South Norwalk, Conn.
Pedrick & Ayer Co., Philadelphia, Pa.
Rand Drill Co., 128 Broadway, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Vulcan Iron Works, Wilkesbarre, Pa.
Henry R. Worthington, 120 Liberty St., New York.

Air Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Air Hoists.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Garry Iron & Steel Roofing Co., Cleveland, Ohio.
Hall Steam Pump Co., Pittsburg, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Air Motors.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.

Alums, Filter.
Harrison Bros. & Co., Inc., Philadelphia, Pa.

Ammeters.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Anti-Friction Metals.
American Engineering Works, Chicago, Ill.
Eastwood Wire Mfg. Co., Belleville, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
R. Poole & Son Co., Baltimore, Md.
Paul S. Reeves & Son, Philadelphia, Pa.

Arc Lamps—See Lamps, Electric.

Asbestos.
H. W. Johns Mfg. Co., 100 William St., New York.

Asbestos Mining and Milling Machinery.
Earle C. Bacon, 26 Cortlandt St., New York.

Automatic Machines.
American Ordnance Co., Bridgeport, Conn.
Pratt & Whitney Co., Hartford, Conn.

Automobiles.
Electric Vehicle Co., 100 B'way, N. Y.

Automobile Engines.
American Ordnance Co., Bridgeport, Conn.

Axles.
American Engineering Works, Chicago, Ill.
Bethlehem Steel Co., South Bethlehem, Pa.

Ball Bearings.
Ball Bearing Co., Boston, Mass.

Belt Dressing.
Jos. Dixon Crucible Co., Jersey City, N. J.
Stephenson Mfg. Co., Albany, N. Y.

Belting.
Aultman Company, Canton, Ohio.
Boston Belting Co., Boston, Mass.
Buhl Malleable Co., Detroit, Mich.
Geo. B. Carpenter & Co., Chicago, Ill.
Eureka Fire Hose Co., 13 Barclay St., N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Engineering Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Chas. A. Schieren & Co., 45-51 Ferry St., N. Y.

Belt Lacing.
Bristol Co., Waterbury, Conn.
Geo. B. Carpenter & Co., Chicago, Ill.

Bending Rolls.
Bement, Miles & Co., Philadelphia, Pa.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Bethlehem Steel Co., South Bethlehem, Pa.
Betts Machine Co., Wilmington, Del.
Cleveland Punch & Shear Works Co., Cleveland, O
Hilles & Jones Co., Wilmington, Del.
Long & Alstatter Co., Hamilton, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Perkins Machine Co., So. Boston, Mass.
Niagara Machine & Tool Works, Buffalo, N. Y.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Blast Furnaces.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Blowers.
American Blower Co., Detroit, Mich.
American Gas Furnace Co., 23 John St., New York.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Massachusetts Fan Co., 53 State St., Boston, Mass.
Northern Electrical Mfg. Co., Madison, Wis.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Boiler Fronts and Fittings.
Ashton Valve Co., Boston, Mass.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

For Alphabetical Index to Advertisers see page 23.

Boiler Compounds

Dearborn Drug & Chemical Works, 29 Rialto, Chicago, Ill.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boiler-Makers' Tools.

Bement, Miles & Co., Philadelphia, Pa.
Betts Machine Co., Wilmington, Del.
Cleveland Punch & Shear Works Co., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.

Boilers.

Alexandroh & Root Mfg. Co., 99 John St., New York.
Allis-Chalmers Co., Chicago, Ill.
American Engineering Works, Chicago, Ill.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Babcock & Wilcox Co., 85 Liberty St., New York.
Earle C. Bacon, 26 Cortlandt St., New York.
Chandler & Taylor Co., Indianapolis, Ind.
Hammond Mfg. Co., Warren, Pa.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Star Drilling Machine Co., Akron, Ohio.
The Stirling Co., Chicago, Ill.

Books.

Association of Engineering Societies, Phila., Pa.
Theo. Audel & Co., 63 Fifth Ave., New York.
Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa.
Eng'g Magazine Press, 120-122 Liberty St., N. Y.

Boring Mills.

American Tool Works Co., Cincinnati, Ohio.
Baush Machine Tool Co., Springfield, Mass.
Bement, Miles & Co., Philadelphia, Pa.
Bullard Machine Tool Co., Bridgeport, Conn.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Box Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Brick.

Henry Maurer & Son, 420 E. 23d St., New York.

Brick and Tile Machinery.

American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Massachusetts Fan Co., 53 State St., Boston, Mass.

Briquetting Machinery.

Henry S. Mould Co., Pittsburg, Pa.

Building Materials.

Chester B. Albree, Allegheny, Pa.
T. H. Brooks & Co., Cleveland, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
H. W. Johns Mfg. Co., 100 William St., New York.
Henry Maurer & Son, 420 E. 23d St., New York.
Passaic Rolling Mill Co., Paterson, N. J.

Cable-Railway Machinery.

Allis-Chalmers Co., Chicago, Ill.
Hazard Mfg. Co., Wilkes-Barre, Pa.
R. Poole & Son Co., Baltimore, Md.

Cables, Electric and Submarine.

General Electric Co., New York.
Hazard Mfg. Co., Wilkes-Barre, Pa.
Okonite Co., Ltd., 253 Broadway, New York.
John A. Roebling's Sons Co., Trenton, N. J.
Western Electric Company, Chicago, Ill.

Cables, Wire.

Geo. B. Carpenter & Co., Chicago, Ill.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calculating Machines.

Carlton Mfg. Co., Carlton Hills, N. J.
Felt & Tarrant Mfg. Co., Chicago, Ill.

Card Index Files.

Rockwell & Rupel Co., 53 La Salle St., Chicago.
Shaw-Walker Co., Muskegon, Mich.
The Fred Macey Co., Grand Rapids, Mich.
Yawman & Erbe Mfg. Co., Rochester, N. Y.

Car Shop Machinery.

American Engineering Works, Chicago, Ill.
American Machinery Co., Grand Rapids, Mich.
Bement, Miles & Co., Philadelphia, Pa.
Betts Machine Co., Wilmington, Del.
Cleveland Punch & Shear Works Co., Cleveland, O.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.

Carriage and Wagon Machinery.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Cast Iron Pipe—See Pipe.

Castings, Iron, Steel and Brass.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Bethlehem Steel Co., South Bethlehem, Pa.
Stanley G. Flagg & Co., Philadelphia, Pa.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Jeffrey Mfg. Co., Columbus, Ohio.
Lima Steel Casting Co., Lima, Ohio.
J. S. Mundy, Newark, N. J.
Paul S. Reeves & Son, Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Walworth Manufacturing Co., Boston, Mass.

Cement Machinery.

Bethlehem Fdy. & Mch. Co., South Bethlehem, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Cement—Portland.

American Cement Co., Philadelphia, Pa.
Atlas Portland Cement Co., 143 Liberty St., N. Y.
H. W. Johns Mfg. Co., 100 William St., New York.
Kelley Island Lime & Transport Co., Cleveland, O.
Lawrence Cement Co., 1 Broadway, New York.

Chain Belting.

Aultman Company, Canton, Ohio.
Buhl Malleable Co., Detroit, Mich.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
J. G. Speidel, Reading, Pa.
Standard Tool and Machine Co., Wilmington, Del.

Chemicals.

Harrison Bros. & Co., Inc., Philadelphia, Pa.
Roessler & Hasslacher Chem. Co., 100 William St., N. Y.

For Alphabetical Index to Advertisers see page 23.

Chemical Works Machinery.

Atlantic Works, East Boston, Mass.

Chemists.

Chas. Catlett, Staunton, Va.
L. B. Darling, 79 Sabin St., Providence, R. I.
Robt. W. Hunt & Co., Chicago, Ill.
O. E. Winters & Geo. Gagan, Philadelphia, Pa.

Clay-Working Machinery.

American Blower Co., Detroit, Mich.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.

Clocks.

American Watchman's Time Detector Co., 234 Broadway, New York.
E. Howard Clock Co., 395 Washington St., Boston, Mass., 43 Maiden Lane, New York.

Clutch Pulleys.

Jacobson Machine Mfg. Co., Warren, Pa.

Coal and Ashes-Handling Machinery.

Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
C. W. Hunt Co., West New Brighton, New York.
Exeter Machine Works, Pittston, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Coal-Mining Machinery.

American Engineering Works, Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York
Buffalo Forge Co., Buffalo, N. Y.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Niles Mine & Mill Supply Co., Cleveland, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal Screens.

Beckley Perforated Screen Works, Garwood, N. J.
Borden & Selleck, Chicago, Ill.
Geo. B. Carpenter & Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles Mine & Mill Supply Co., Cleveland, Ohio.

Compressed Air Shop Tools.

Pedrick & Ayer Co., Philadelphia, Pa.

Condensers.

Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Hammond Mfg. Co., Warren, Pa.
Holly Mfg. Co., 126 Liberty St., New York.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Henry R. Worthington, 120 Liberty St., New York

Contractors' Supplies.

Geo. B. Carpenter & Co., Chicago, Ill.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
H. W. Johns Mfg. Co., 100 William St., New York.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Monongahela Mfg. Co., Monongahela, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.

Conveying Machinery.

Aultman Company, Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
E. A. Blanton, Jr., Philadelphia, Pa.
Borden & Selleck Co., Chicago, Ill.
Buhl Malleable Co., Detroit, Mich.
Durable Wire Rope Co., Boston, Mass.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Copper.

Orford Copper Co., 37 Wall St., New York.

Cordage.

American Mfg. Co., 63 Wall St., New York.
Broderick & Bascom Rope Co., St. Louis, Mo.
Geo. B. Carpenter & Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Durable Wire Rope Co., Boston, Mass.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Waterbury Rope Co., 69 South St., New York.

Cranes.

Earle C. Bacon, 26 Cortlandt St., New York.
Brown Hoisting Mchy. Co., Inc., Cleveland, O.
Browning Engineering Co., Cleveland, Ohio.
Garry Iron & Steel Roofing Co., Cleveland, Ohio.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
J. G. Speidel, Reading, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Crushers—Ore, Phosphate, Rock.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
E. A. Blanton, Jr., Philadelphia, Pa.
Geo. V. Cresson Co., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Cupolas.

Northern Engineering Works, Detroit, Mich.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Cutters, Milling.

Brown & Sharpe Mfg. Co., Providence, R. I.

Diamond Drills.

American Diamond Rock Drill Co., 120 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 128 Broadway, New York.

Digesters.

Atlantic Works, East Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Draw Benches, Wire.

Morgan Construction Co., Worcester, Mass.
Mossberg & Granville Mfg. Co., Providence, R. I.
Trenton Iron Co., Trenton, N. J.
Watson-Stillman Co., 204 East 43d St., New York.

Draughtsmen's Instruments and Materials.

Theo. Altenedер & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.

For Alphabetical Index to Advertisers see page 23.

Buff & Buff Mfg. Co., 506-510 Atlantic Ave., Boston, Mass.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., New York.
Queen & Co., Inc., Philadelphia, Pa.

Drilling Machines.

American Tool Works Co., Cincinnati, Ohio.
B. F. Barnes Co., Rockford, Ill.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Cleveland Punch & Shear Works Co., Cleveland, O.
Thos. H. Dallett & Co., Philadelphia, Pa.
Niles Tool Works Co., Hamilton, Ohio.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
A. D. Quint, Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drills—Rock and Coal.

American Diamond Rock Drill Co., 120 Liberty St., New York.
E. A. Blanton, Jr., Philadelphia, Pa.
H. D. Crippen, 52 B'way, N. Y.
Davis Calyx Drill Co., 128 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Howells Mining Drill Co., Plymouth, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
McKiernan Drill Co., 120 Liberty St., New York.
Rand Drill Co., 128 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.

Drop Hammers.

Bement, Miles & Co., Philadelphia, Pa.
Long & Allstatter Co., Hamilton, Ohio.
Mossberg & Granville Mfg. Co., 150 Nassau St., N.Y.
Perkins Machine Co., So. Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Williams, White & Co., Moline, Ill.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Earle C. Bacon, 26 Cortlandt St., New York.
Buffalo Forge Co., Buffalo, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Massachusetts Fan Co., 53 State St., Boston, Mass.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Dynamite.

Nitro Powder Co., Kingston, N. Y.

Dynamos.

American Engine Co., Bound Brook, N. J.
Chas. J. Bogue, 217 Centre St., New York.
Bullock Electric Mfg. Co., Cincinnati, Ohio
C & C Electric Co., 143 Liberty St., New York.
Eddy Electric Mfg. Co., Windsor, Conn.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., New York.
The Holtzer-Cabot Electric Co., Brookline, Mass.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Northern Electrical Mfg. Co., Madison, Wis.
Onondaga Dynamo Co., Syracuse, N. Y.
Schureman & Hayden, 137 So. Clinton St., Chicago, Ill.
Sprague Electric Co., 527 W. 34th St., New York.
Stanley Electric Mfg. Co., Pittsfield, Mass.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Ejectors.

Watson & McDaniel Co., Philadelphia, Pa.

Electrical Machinery and Supplies.

American Engine Co., Bound Brook, N. J.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Bristol Co., Waterbury, Conn.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
C & C Electric Co., 143 Liberty St., New York.
Consolidated Railway Electric Lighting & Equipment Co., 100 Broadway, New York.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Deane Steam Pump Co., Holyoke, Mass.
Eddy Electric Mfg. Co., Windsor, Conn.
General Electric Co., New York.
Holly Mfg. Co., 120 Liberty St., New York.
The Holtzer-Cabot Electric Co., Brookline, Mass.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
H. W. Johns Mfg. Co., 100 William St., New York.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Massachusetts Fan Co., 53 State St., Boston, Mass.
M. M. Mayer Elec. Co., 2369 Second Ave., N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Onondaga Dynamo Co., Syracuse, N. Y.
Wm. E. Quimby, Inc., 86 Liberty St., New York.
Schureman & Hayden, 137 So. Clinton St., Chicago, Ill.
Snow Steam Pump Works, Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
Stanley Electric Mfg. Co., Pittsfield, Mass.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Western Electric Company, Chicago, Ill.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.
Henry R. Worthington, 120 Liberty St., New York.

Electrical Car Lighting.

Consolidated Railway Electric Lighting & Equipment Co., 100 Broadway, New York.

Electro-Galvanizing.

U. S. Electro-Galvanizing Co., 348 Broadway, N. Y.

Elevators.

American Tool & Machine Co., Boston, Mass.
Aultman Co., Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Buhl Malleable Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
J. G. Speidel, Reading, Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Triumph Electric Co., Cincinnati, Ohio.
Whiting Foundry Equipment Co., Harvey, Ill.

Emery Wheels.

Carborundum Co., Niagara Falls, N. Y.
Geo. B. Carpenter & Co., Chicago, Ill.
Norton Emery Wheel Co., Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.

Employees Registering Clocks.

American Watchman's Time Detector Co., 234 Broadway, New York.

Engineers.

Daniel Ashworth, 515 Penn Ave., Pittsburg, Pa.
William M. Brewer, Molson's Bank Building, Vancouver, B. C.
G. M. Brill, 1143-5 Marquette Bldg., Chicago, Ill.
Madison Cooper, Minneapolis, Minn.
W. Dusodiau, 529 Min'g Exchge Bldg., Denver, Colo.
Holt & Schober, 378 Bourse, Philadelphia, Pa.
S. V. Huber & Co., 702-707 Ferguson Block, Pittsburg, Pa.
Robt. W. Hunt & Co., 1121 The Rookery, Chicago, Ill.
Julian Kennedy, Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
David Lamond, 710 Ferguson Block, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
James J. Pearson, 40 Wall St., New York.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.

For Alphabetical Index to Advertisers see page 23.

C. L. Redfield, 269 Dearborn St., Chicago, Ill.
Sydney F. Reynolds, Torry, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Arthur Hovey Storrs, Scranton, Pa.
Smith & Aldrich, Toronto, Can.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Blowing.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Sprague Electric Co., 527 W. 34th St., New York.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Northern Engineering Works, Detroit, Mich.
Struthers, Wells & Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.

Engines, Stationary.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., 120 Liberty St., New York.
Buffalo Forge Co., Buffalo, N. Y.
Erie Pump & Engine Co., Erie, Pa.
Frick Company, Waynesboro, Pa.
Chandler & Taylor Co., Indianapolis, Ind.
Harrisburg Fdy. & Mch. Co., Harrisburg, Pa.
Hooven, Owens Rentschler Co., Hamilton, Ohio.
James Leffel & Co., Springfield, O.
Star Drilling Machine Co., Akron, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engine Stops.

Monarch Mfg. Co., Waterbury, Conn.

Engravers.

A. Mugford, 120 Liberty St., New York.

Excavators.

Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.
Aultman Company, Canton, Ohio.
Bucyrus Co., So. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Vulcan Iron Works, Toledo Ohio.

Exhaust Heads.

Boston Blower Co., Hyde Park, Mass.
Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Explosives.

Nitro Powder Co., Kingston, N. Y.

Fans, Ventilating.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
Massachusetts Fan Co., 53 State St., Boston, Mass.
Northern Electrical Mfg. Co., Madison, Wis.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.
Western Electric Company, Chicago, Ill.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Chicago, Ill.
Earle C. Bacon, 26 Cortlandt St., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Goubert Mfg. Co., 85 Liberty St., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Wm. S. Haines Co., Philadelphia, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
Industrial Water Co., 15 Wall St., New York.
John H. McGowan Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
Stewart Heater Co., Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Warren Webster & Co., Camden, N. J.
Wefugo Company, Cincinnati, Ohio.

Fertilizer Machinery.

Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.
Geo. B. Carpenter & Co., Chicago, Ill.

Filters.

Industrial Water Co., 15 Wall St., New York.
New York Cont. Jewell Filt. Co., 15 Broad St., N. Y.
Wefugo Company, Cincinnati, O.

Fire Brick.

Henry Maurer & Son, 420 East 23d St., New York.

Fire Hose.

Boston Belting Co., Boston, Mass.
Eureka Fire Hose Co., 13 Barclay St., N. Y.

Fireproofing Building Materials.

Henry Maurer & Son, 420 East 23d St., New York.
National Fireproofing Co., Pittsburg, Pa.

Flanges.

Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flexible Shafts.

Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Floor Plates.

Ogden & Wallace, 577-583 Greenwich St., New York.

Flue Cleaners.

Stephenson Mfg. Co., Albany, N. Y.

Flushing Valves.

Kenney Company, 72-74 Trinity Place, N. Y.

Fly Wheels.

Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co. Mishawaka, Ind.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
Crumlish Forge Co., Buffalo, N. Y.
Boston Blower Co., Hyde Park, Mass.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

For Alphabetical Index to Advertisers see page 23.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Pa.
Bethlehem Steel Co., South Bethlehem, Pa.
Keystone Drop Forge Works, Philadelphia, Pa.
Mossberg & Granville, Mfg. Co., 150 Nassau St., N.Y.
Strieby & Foote Co., Newark, N. J.
J. H. Williams & Co., 9 Richards St., Brooklyn, N.Y.
Wyman & Gordon, Worcester, Mass.

Foundry Equipment.

Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
Whiting Foundry Equipment Co., Harvey, Ill.

Friction Clutches.

American Tool & Machine Co., Boston, Mass.
Christiana Machine Co., Christiana, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Eastern Machinery Co., New Haven, Conn.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Fuel Economizers.

Green Fuel Economizer Co., Matteawan, N. Y.

Furnace Builders.

American Gas Furnace Co., 23 John St., New York.
Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Gages—Pressure, Steam, Water, etc.

Ashton Valve Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Crosby Steam Gage & Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., 32 Elizabeth St., Rochester, N. Y.
Replogle Governor Works, Akron, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.
Williams Gauge Co., W. Pittsburg, Pa.

Galvanizing.

U. S. Electro-Galvanizing Co., 348 Broadway, N. Y.

Gas Holders and Regulators.

Continent. Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Jacobson Machine Mfg. Co., Warren, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Metallic.

Geo. B. Carpenter & Co., Chicago, Ill.
H. W. Johns Mfg. Co., 100 William St., New York.
Merwarth Metal Gasket Co., 107 Liberty St., N. Y.

Gas Machines and Generators.

American Gas Furnace Co., 23 John St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gas Soldering Furnaces.

Jacobson Machine Mfg. Co., Warren, Pa.

Gauges, Pressure, Steam, Water, etc.

Brown & Sharpe Mfg. Co., Providence, R. I.

Gearing.

Allis-Chalmers Co., Chicago, Ill.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Borden & Selleck Co., Chicago, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Christiana Machine Co., Christiana, Pa.
Geo. V. Cresson Co., Philadelphia, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Jacobson Mch. Mfg. Co., Warren, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Morse, Williams & Co., Philadelphia, Pa.
J. S. Mundy, Newark, N. J.
New Process Rawhide Co., Syracuse, N. Y.
R. Poole & Son Co., Baltimore, Md.
William Sellers & Co., Inc., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Grain Elevator Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Graphite.

Geo. B. Carpenter & Co., Chicago, Ill.
Jos. Dixon Crucible Co., Jersey City, N. J.

Grinding and Polishing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Machine Co., Providence, R. I.
Dodge Mfg. Co. Mishawaka, Ind.
Landis Tool Co., Waynesboro, Pa.
Niles Tool Works Co., Hamilton, Ohio.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hangers—See Pulleys.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Massachusetts Fan Co., 53 State St., Boston, Mass.
Sprague Electric Co., 527 W. 34th St., New York.
H. B. Smith Co., 137 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Mfg. Co., Boston, Mass.

Hoisting Engines and Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
Borden & Selleck Co., Chicago, Ill.
Brown Hoisting Machinery Co., Inc., Cleveland, O
Browning Engineering Co., Cleveland, Ohio.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Exeter Machine Works, Pittston, Pa.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa
Monongahela Mfg. Co., Monongahela, Pa.
J. S. Mundy, Newark, N. J.
Niles Tool Works Co., Hamilton, Ohio.
Northern Engineering Works, Detroit, Mich.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works, Wilkesbarre, Pa.
Webster, Camp & Lane Machine Co., Akron, O.

Hollow Chisel Mortisers.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Hose.

Eureka Fire Hose Co., 13 Barclay St., N. Y.
Boston Belting Co., Boston, Mass.

For Alphabetical Index to Advertisers see page 23.

Hydraulic Machinery.

Bement, Miles & Co., Philadelphia, Pa.
Christiana Machine Co., Christiana, Pa.
John H. McGowan Co., Cincinnati, Ohio.
S. Morgan Smith Co., York, Pa.
R. Poole & Son Co., Baltimore, Md.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Rams.

Power Specialty Co., 126 Liberty St., New York.

Ice-Making and Refrigerating Machinery.

A. H. Barber Mfg. Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Frick Company, Waynesboro, Pa.
Holly Mfg. Co., 120 Liberty St., New York.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
H. B. Roelker, 41 Maiden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Triumph Ice Machine Co., Cincinnati, O.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Henry R. Worthington, 120 Liberty St., New York.

Incandescent Lamps—See Lamps, Electric.

Industrial Railways.

Borden & Selleck Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.
Arthur Koppel, 68 Broad St., New York.

Injectors.

The Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.

Insulated Wire.

General Electric Co., New York.
Hazard Mfg. Co., Wilkes-Barre, Pa.
Okonite Co., Ltd., 253 Broadway, New York.
John A. Roebling's Sons Co., Trenton, N. J.
Sprague Electric Co., 527 W. 34th St., New York.

Insulating Varnish.

Sterling Varnish Co., Pittsburg, Pa.

Kiers.

Atlantic Works, East Boston, Mass.

Kyanizing.

Otis Allen & Son, Lowell, Mass.

Lamps, Electric.

Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., New York.
General Incandescent Lamp Co., Cleveland, Ohio.
Sawyer-Man Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Western Electric Company, Chicago, Ill.

Lathes.

American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, O.
Diamond Machine Co., Providence, R. I.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
W. C. Young Mfg. Co., Worcester, Mass.

Leather Fillet.

A. G. Butler, cor. Beckman & Pearl Sts., N. Y.

Leather, Hydraulic, Valve and Pump.

Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Link Belting.

Buhl Malleable Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Richmond Loco. & Mch. Works, Richmond, Va.
Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Lockers.

Merritt & Co., Philadelphia, Pa.
Narragansett Machinery Co., Providence, R. I.

Locomotives, Steam.

Baldwin Locomotive Works, Philadelphia, Pa.
Pittsburg Locomotive Works, Pittsburg, Pa.
H. K. Porter Co., Pittsburg, Pa.
Vulcan Iron Works, Wilkesbarre, Pa.

Locomotives, Electric.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Machine Tools and Supplies.

Acme Machinery Co., Cleveland, Ohio.
American Engineering Works, Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, O.
R. F. Barnes Co., Rockford, Ill.
W. F. & John Barnes Co., Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bement, Miles & Co., Philadelphia, Pa.
Betts Machine Co., Wilmington, Del.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Machine Tool Co., Bridgeport, Conn.
Cincinnati Milling Machine Co., Cincinnati, O.
Cleveland Punch & Shear Works Co., Cleveland, O.
Hilles & Jones Co., Wilmington, D. I.
Jones & Lamson Machine Co., Springfield, Vt.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Niles Tool Works Co., Hamilton, O.
Pearson Machine Co., Chicago, Ill.
Pond Machine Tool Co., Plainfield, N. J.
Power Specialty Co., 126 Liberty St., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
A. D. Quint, Hartford, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walworth Manufacturing Co., Boston, Mass.
Whitcomb Mfg. Co., Worcester, Mass.
W. C. Young Mfg. Co., Worcester, Mass.

Machinists' Small Tools.

Acme Machinery Co., Cleveland, Ohio.
American Tool Works Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Marine Machinery.

Chas. J. Bogue, 217 Centre St., New York.
Geo. B. Carpenter & Co., Chicago, Ill.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Star Brass Mfg. Co., Boston, Mass.

Mechanical Draft.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Massachusetts Fan Co., 53 State St., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

For Alphabetical Index to Advertisers see page 23.

Meters, Electric.

General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Milling Machines.

Adams Company, Dubuque, Iowa.
Beaman & Smith, Providence, R. I.
Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, O.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Mill Supplies.

Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Mine Cars.

American Engineering Works, Chicago, Ill.
Earle C. Bacon, 26 Cortlandt St., New York.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
Niles Mine & Mill Supply Co., Cleveland, Ohio.
Watt Mining Car Wheel Co., Barnesville, Ohio.
Whiting Foundry Equipment Co., Harvey, Ill.

Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Diamond Rock Drill Co., 120 Liberty St., New York.
American Engineering Works, Chicago, Ill.
Earle C. Bacon, 26 Cortlandt St., New York.
E. A. Blanton, Jr., Philadelphia, Pa.
Beckley Perforated Screen Works, Garwood, N. J.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Davis Calyx Drill Co., 128 Broadway, New York.
Deane Steam Pump Co., Holyoke, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
General Electric Co., New York.
Wm. Harris & Son, Pittsburg, Pa.
Holly Mfg. Co., 120 Liberty St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John H. McGowan Co., Cincinnati, Ohio.
McKiernan Drill Co., 120 Liberty St., New York.
Monongahela Mfg. Co., Monongahela, Pa.
J. S. Mundy, Newark, N. J.
Niles Mine & Mill Supply Co., Cleveland, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
The Patent Record, Baltimore, Md.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Malden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Trenton Iron Works Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.
Watt Mining Car Wheel Co., Barnesville, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Henry R. Worthington, 120 Liberty St., New York.

Mining Screens—See Screens.

Motors, Electric.

American Engine Co., Bound Brook, N. J.
Chas. J. Bogue, 217 Centre St., New York.
Bullock Electric Mfg. Co., Cincinnati, Ohio.
C & C Electric Co., 145 Liberty St., New York.
Eddy Electric Mfg. Co., Windsor, Conn.
General Electric Co., New York.
The Holtzer-Cabot Electric Co., Brookline, Mass.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Northern Electrical Mfg. Co., Madison, Wis.
Onondaga Dynamo Co., Syracuse, N. Y.
Schureman & Hayden, 137 So. Clinton St., Chicago, Ill.
Sprague Electric Co., 527 W. 34th St., New York.
Stanley Electric Mfg. Co., Pittsfield, Mass.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Naphtha Gas Machines.

American Gas Furnace Co., 23 John St., New York.

Nickel.

Orford Copper Co., 37 Wall St, New York.

Nickel-Steel.

Bethlehem Steel Co., South Bethlehem, Pa.

Oil and Steam Separators.

Warren Webster & Co., Camden, N. J.

Open Hearth Furnaces.

G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Ore-Roasting Machinery

Allis-Chalmers Co., Chicago, Ill.

Packing.

Boston Belting Co., Boston, Mass.
Geo. B. Carpenter & Co., Chicago, Ill.
Jenkins Brothers, 71 John St., New York.
H. W. Johns Mfg. Co., 100 William St., New York.
Merwarth Metal Gasket Co., 107 Liberty St., N. Y.
Quaker City Rubber Co., Philadelphia, Pa.
U. S. Metallic Packing Co., Philadelphia, Pa.

Paints and Varnishes.

Asphalt Rubber Paint Co., Washington, D. C.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Inc., Philadelphia, Pa.
H. W. Johns Mfg. Co., 100 William St., New York.
U. S. Gutta Percha Paint Co., Providence, R. I.

Paper-Mill Machinery.

Aultman Company, Canton, Ohio.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Dodge Mfg. Co., Mishawaka, Ind.
Holly Mfg. Co., 120 Liberty St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Snow Steam Pump Works, Buffalo, N. Y.
Henry R. Worthington, 120 Liberty St., New York.

Patent Attorneys.

C. A. Dieterich, 229 Broadway, New York.
Victor J. Evans & Co., Evans Building, Washington, D. C.

Pattern Letters.

A. G. Butler, cor. Beekman & Pearl Sts., N. Y.

Pattern-Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Perforated Metal.

Robt. Aitchinson Perforated Metal Co., Chicago, Ill.

Pipe, Cast-Iron.

Abendroth & Root Mfg. Co., 99 John St., New York.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.

Pipe Coverings.

H. W. Johns Mfg. Co., 100 William St., New York.
Michigan Pipe Co., Bay City, Mich.

For Alphabetical Index to Advertisers see page 23.

Pipe-Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Cox & Sons Company, Bridgeton, N. J.
Merrell Mfg. Co., Toledo, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.

Abendroth & Root Mfg. Co., 99 John St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Vises.

Standard Tool and Machine Co., Wilmington, Del.

Planers.

American Tool Works Co., Cincinnati, Ohio.
Bement, Miles & Co., Philadelphia, Pa.
Betts Machine Co., Wilmington, Del.
Cleveland Punch & Shear Works Co., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Whitcomb Mfg. Co., Worcester, Mass.
W. A. Wilson, Rochester, N. Y.

Planing Mill Machinery.

American Machinery Co., Grand Rapids, Mich.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Platinum Ware.

J. C. Entriken, Malvern, Pa.

Pneumatic Riveters.

Pedrick & Ayer Co., Philadelphia, Pa.

Pneumatic Tools.

American Engineering Works, Chicago, Ill.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
F. F. Slocomb & Co., Wilmington, Del.

Pop Safety Valves.

Consolidated Safety Valve Co., 85-87-89 Liberty St., New York.
Star Brass Mfg. Co., Boston, Mass.

Power Hammers.

American Engineering Works, Chicago, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Cleveland Punch & Shear Works Co., Cleveland, O
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.

Power-Transmission Machinery.

American Engineering Works, Chicago, Ill
Aultman Company, Canton, Ohio.
Geo. B. Carpenter & Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Geo. V. Cresson Co., Philadelphia, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles Tool Works Co., New York, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
S. Morgan Smith Co., York, Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Presses and Dies.

Mossberg & Granville Mfg. Co., 150 Nassau St., N.Y.
Niagara Machine & Tool Works, Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Watson & Stillman Co., 240 East 43d St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Prospecting Drills.

American Diamond Rock Drill Co., 120 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.

Pulleys, Shafting and Hangers.

Allis-Chalmers Co., Chicago, Ill.
American Engineering Works, Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Aultman Company, Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
Borden & Selleck Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Geo. V. Cresson Co., Philadelphia, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Niles Tool Works Co., New York, N. Y.
R. Poole & Son Co., Baltimore, Md.
Rockwood Mfg. Co., Indianapolis, Ind.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Pump Governors.

Mason Regulator Co., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.

Pumps and Pumping Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Engineering Works, Chicago, Ill.
American Well Works, Aurora, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., N. Y.
Bucyrus Co., So. Milwaukee, Wis.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Geo. B. Carpenter & Co., Chicago, Ill.
The Deane Steam Pump Co., of Holyoke, 120 Liberty St., New York.
Erie Pump & Engine Co., Erie, Pa.
Flint & Walling Mfg. Co., Kendallville, Ind
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
The Holly Mfg. Co., 120 Liberty St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y
John H. McGowan Co., Cincinnati, Ohio.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Knowles Steam Pump Wks., 91 Liberty St., N. Y
The Laidlaw-Dunn-Gordon Co., 120 Liberty St., N.Y.
Morris Machine Works, Baldwinsville, N. Y.
Pneumatic Eng'g Co., 128 Broadway, N. Y.
Pulsometer Steam Pump Co., 135 Greenwich St., New York.
Wm. E. Quimby, 86 Liberty St., New York.
Rider-Ericsson Eng. Co., 24 Cortlandt St., N. Y.
Snow Steam Pump Works, 120 Liberty St., N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 120 Liberty St., New York.

Pump Valves.

Boston Belting Co., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.

Punching and Shearing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Bement, Miles & Co., Philadelphia, Pa.
Bethlehem Foundry & Mch. Co., So. Bethlehem, Pa.
Betts Machine Co., Wilmington, Del.
Cleveland Punch & Shear Works Co., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles Tool Works Co., Hamilton, O.
Perkins Machine Co., So. Boston, Mass.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Tool and Machine Co., Wilmington, Del.
W. C. Young Mfg. Co., Worcester, Mass.

Quarrying Machinery.

A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
John H. McGowan Co., Cincinnati, Ohio.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.

For Alphabetical Index to Advertisers see page 23.

Radial Drills.

Bickford Drill & Tool Co., Cincinnati, Ohio.

Radiators.

A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
H. B. Smith Co., 137 Centre St., New York.

Railway Shop Machinery.

American Engineering Works, Chicago, Ill.
Chester B. Albree, Allegheny, Pa.
Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Betts Machine Co., Wilmington, Del.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Cleveland Punch & Shear Works Co., Cleveland, O.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Pedrick & Ayer Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.

Railway Specialties.

Geo. B. Carpenter & Co., Chicago, Ill.
Consolidated Railway Electric Lighting & Equipment Co., 100 Broadway, New York.
Goodwin Car Co., 96 Fifth Ave., New York.
H. W. Johns Mfg. Co., 100 William St., New York.
Arthur Koppel, 68 Broad St., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stanley Electric Mfg. Co., Pittsfield, Mass.
Star Brass Mfg. Co., Boston, Mass.
Westinghouse Air Brake Co., Pittsburg, Pa.

Refrigerating Machinery — See Ice-Making Machinery.

Riveting Machines.

American Engineering Works, Chicago, Ill.
Chester B. Albree, Allegheny, Pa.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Bement, Miles & Co., Philadelphia, Pa.
Betts Machine Co., Wilmington, Del.
Cleveland Punch & Shear Works Co., Cleveland, O.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Road-Making Machinery.

Aultman Co., Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Rock Breakers.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Geo. V. Cresson Co., Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.

Roofing.

Eastern Granite Rfg. Co., Gerken Building, N. Y.
H. W. Johns Mfg. Co., 100 William St., New York.
Passaic Rolling Mill Co., Paterson, N. J.
Warren Chemical & Mfg. Co., 81 Pearson St., N. Y.

Rope—See Cordage.

Rope Transmission.

Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
Geo. B. Carpenter & Co., Chicago, Ill.
Geo. V. Cresson Co., Philadelphia, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Durable Wire Rope Co., Boston, Mass.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engg Co., Nicetown, Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.

Rubber Goods.

Boston Belting Co., Boston, Mass.
Geo. B. Carpenter & Co., Chicago, Ill.
Eureka Fire Hose Co., 13 Barclay St., N. Y.
Jenkins Bros., 71 John St., New York.
Quaker City Rubber Co., Philadelphia, Pa.

Saw-Mill Machinery.

Allis-Chalmers Co., Chicago, Ill.
Chandler & Taylor Co., Indianapolis, Ind.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio.

Schools.

International Correspondence Schools, Scranton, Pa.
Lehigh University, So. Bethlehem, Pa.
Lafayette College, Easton, Pa.
Mass. Institute of Technology, Boston, Mass.
McGill University, Montreal.
Michigan College of Mines, Houghton, Mich.
New York Military Academy, Cornwall, N. Y.
Pratt Institute, Brooklyn, N. Y.
Purdue University, Lafayette, Ind.
Rensselaer Polytechnic Institute, Troy, N. Y.
Rose Polytechnic Institute, Terre Haute, Ind.
Sheffield Scientific School of Yale University, New Haven, Conn.
Stevens Institute of Technology, Hoboken, N. J.
Thayer School of Civil Engineering, Hanover, N. H.
University of Kansas, Lawrence, Kan.
University of Tennessee, Knoxville, Tenn.
University of Wisconsin, Madison, Wis.
Worcester Polytechnic Institute, Worcester, Mass.

Screens, Mining.

Robert Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Earle C. Bacon, 26 Cortlandt St., New York.
Beckley Perforated Screen Works, Garwood, N. J.
Borden & Selleck Co., Chicago, Ill.
Eastwood Wire Mfg. Co., Belleville, N. J.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Niles Mine & Mill Supply Co., Cleveland, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Screw Machines.

American Tool Works Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pearson Machine Co., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Rivett-Dock Co., Brighton, Boston, Mass.

Search Lights and Projectors.

Chas. J. Bozzie, 217 Centre St., New York.

Separators, Steam and Oil.

Austin Separator Co., Detroit, Mich.
Earle C. Bacon, 26 Cortlandt St., New York.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., 85 Liberty St., New York.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Wm. S. Haines Co., Philadelphia, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Watson & McDaniel Co., Philadelphia, Pa.

Shafting—See Pulleys.

Shapers.

American Tool Works Co., Cincinnati, Ohio.
Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Perkins Machine Co., So. Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

For Alphabetical Index to Advertisers see page 23.

Shears—See Punching Machinery.

Special Machinery.

American Ordnance Co., Bridgeport, Conn.
Perkins Machine Co., So. Boston, Mass.

Spiral Riveted Pipe.

Abendroth & Root Mfg. Co., 99 John St., New York.

Steam-Regulating Appliances.

Harrison Safety Boiler Works, Philadelphia, Pa.
Jenkins Brothers, 71 John St., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., W. Pittsburg, Pa.

Separators, Steam and Oil.

Austin Separator Co., Detroit, Mich.
Direct Separator Co., Syracuse, N. Y.

Steam Specialties.

American District Steam Co., Lockport, N. Y.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
The Lunkenheimer Co., Cincinnati, O.
Mason Regulator Co., Boston, Mass.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wm. H. Wilkinson & Co., 352 Atlantic Ave., Boston, Mass.

Steam Superheaters.

Power Specialty Co., 126 Liberty St., New York.

Steam Traps.

American Blower Co., Detroit, Mich.
American District Steam Co., Lockport, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
Wm. S. Haines Co., Philadelphia, Pa.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Steel.

Bethlehem Steel Co., South Bethlehem, Pa.
Wm. Jessop & Sons, Ltd., 91 John St., New York.
Latrobe Steel Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Walworth Manufacturing Co., Boston, Mass.

Stokers—Mechanical.

Babcock & Wilcox Co., 85 Liberty St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Structural Iron Work.

Chester B. Albree, Allegheny, Pa.
American Bridge Co., 100 Broadway, New York.
Browning Engineering Co., Cleveland, Ohio.
Passaic Rolling Mill Co., Paterson, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Sugar-House Machinery.

American Tool & Machine Co., Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Tanks, Iron.

Allis-Chalmers Co., Chicago, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
L. O. Koven & Brother, 50 Cliff St., New York.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.

Tanks, Wood.

W. E. Caldwell Co., Louisville, Ky.

Tape, Insulating.

Okonite Company, Ltd., 253 Broadway, New York.

Tapping and Reaming Machines.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
A. D. Quint, Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Telephones.

Ericsson Telephone Co., 296 Broadway, New York
The Holtzer-Cabot Electric Co., Brookline, Mass.

Tenoning Machines.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Thermometers.

Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., 32 Elizabeth St., Rochester, N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Tower Clocks.

E. Howard Clock Co., 395 Washington St., Boston, Mass., 43 Maiden Lane, New York.

Traveling Cranes.

Shaw Electric Crane Co., Muskegon, Mich.

Turbine Water-Wheels.

Christiana Machine Co., Christiana, Pa.
James Leffel & Co., Springfield, Ohio.
Pelton Water Wheel Co., San Francisco, Cal.
R. Poole & Son Co, Baltimore, Md.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio
R. D. Wood & Co., Philadelphia, Pa.

Turnbuckles.

Merrill Bros., 477 Kent Ave., Brooklyn, N. Y.

Turn Tables.

Dodge Mfg. Co., Mishawaka, Ind.
Passaic Rolling Mills Co., Paterson, N. J.
Wm. Sellers & Co., Philadelphia, Pa.

Turret Lathes.

American Turret Lathe Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Pearson Machine Co., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Vacuum Pumps.

A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air-Compress. Wks., 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Guild & Garrison, Brooklyn, N. Y.
John H. McGowan Co., Cleveland, Ohio.
Pearson Machine Co., Chicago, Ill.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Valve Handles.

Troy Nickel Works, Albany, N. Y.

Valves.

Consolidated Safety Valve Co., 85-87-89 Liberty St., New York.

Valves—Gas, Steam, and Water.

American District Steam Co., Lockport, N. Y.
Consolidated Safety Valve Co., 85-87-89 Liberty St., New York.
Crosby Steam Gage & Valve Co., Boston, Mass.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Eastwood Wire Mfg. Co., Belleville, N. J.
Jenkins Bros., 71 John St., New York.
Kennedy Valve Mfg. Co., 70 Beekman St., N. Y.
The Lunkenheimer Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Mason Regulator Co., Boston, Mass.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New York.
Wm. Powell Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Ventilating Appliances.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.

For Alphabetical Index to Advertisers see page 23.

Massachusetts Fan Co., 53 State St., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Wage Calculators.

Carlton Mfg. Co., Carlton Hills, N. J.

Watchman's Time Detectors.

American Watchmen's Time Detector Co., 234 & 235 Broadway, New York.
The Holtzer-Cabot Electric Co., Brookline, Mass.
E. Howard Clock Co., 395 Washington St., Boston Mass., 43 Maiden Lane, New York.

Water-Closets.

Kenney Company, 72-74 Trinity Place, N. Y.,

Water Lifts.

American Well Works, Aurora, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Pneumatic Engineering Co., 128 B'way, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.

Water Meters.

Builders' Iron Foundry, Providence, R. I.
Standard Water Meter Co., 22-26 Reade St., N. Y.

Water Motors.

Standard Water Meter Co., 22-26 Reade St., N. Y.

Water Softening Plants.

Industrial Water Co., 15 Wall St., New York.
Wefugo Company, Cincinnati, O.

Water-Works Pumping Machinery.

Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Holly Mfg. Co., 120 Liberty St., New York.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 120 Liberty St., New York.

Water-Works Supplies.

American Well Works, Aurora, Ill.
W. E. Caldwell Co., Louisville, Ky.
Replogle Governor Works, Akron, Ohio.
Star Drilling Machine Co., Akron, Ohio.
U. S. Cast Iron Pipe & Foundry Co., Phila., Pa.
R. D. Wood & Co., Philadelphia, Pa.

Water Wheel Governors.

Replogle Governor Works, Akron, Ohio.

Well-Sinking and Prospecting Machinery.

American Diamond Rock Drill Co., 120 Liberty St., New York.
American Well Works, Aurora, Ill.
Star Drilling Machine Co., Akron, Ohio
Williams Bros., Ithaca, N. Y.

Wind Mills.

W. E. Caldwell Co., Louisville, Ky.
Flint & Walling Mfg. Co., Kendallville, Ind.

Wire, Copper.

Bridgeport Brass Co., 19 Murray St., New York.

Wire, Insulated—See Insulated Wire.

Wire Rope.

Broderick & Bascom Rope Co., St. Louis, Mo.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Durable Wire Rope Co., Boston, Mass.
Hazard Mfg. Co., Wilkes-Barre, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Phosphor Bronze Smelt. Co., Ltd., Philadelphia, Pa.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.
Waterbury Rope Co., 69 South St., New York.

Wood-Working Machinery.

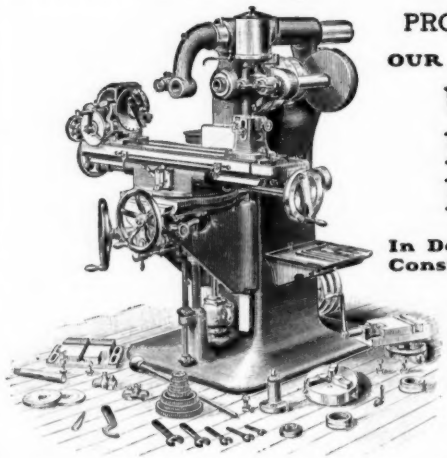
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
H. B. Smith Machine Co., Smithville, N. J.
Stow Flexible Shaft Co., Philadelphia, Pa.

Wrenches.

Coes Wrench Co., Worcester, Mass.

Brown & Sharpe Manufacturing Co.,

PROVIDENCE, R. I., U. S. A.



OUR

Universal Milling Machines

In Design and Construction are

ACCURATE, STRONG, SERVICEABLE, ECONOMICAL.

We shall be pleased to mail descriptive circulars and general catalogue to any address, upon application.

ATLANTIC, GULF AND PACIFIC CO.

Hydraulic Dredge discharging through 5,700 ft. of pipe.

ENGINEERS AND CONTRACTORS

Geo. W. CATT, M. Am. Soc. C. E., M. Inst. C. E., Pres. & Eng. THOS. J. LONG, M. Am. Soc. C. E., Vice Pres. & Engr.
H. S. WOOD, C. E., Sec. & Treas. H. KRUSI, C.E., Pac. Coast Man. R. A. PERRY, Supt

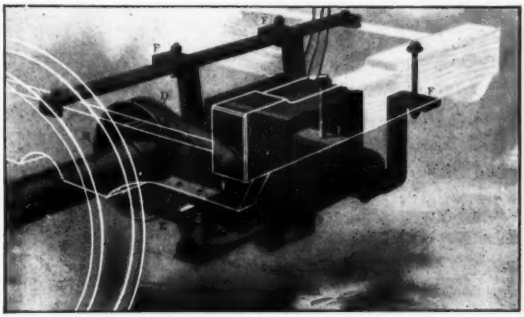
SPECIALTIES: Dredging, Dredging Machines, Land Reclamation, Docks, Piers, Foundations, Bridges.
Correspondence solicited.

MAIN OFFICE: PARK ROW BUILDING, NEW YORK.
PACIFIC COAST OFFICE: 220 MARKET STREET, SAN FRANCISCO, CAL.

The Consolidated "Axle Light" System.

A Perfect System of Lighting for Railway Trains and Coaches by Electricity Generated from the Car Axle.

The "Axle Light" System is being adopted on the Leading Railway lines and is giving entire satisfaction. The cost of Maintenance is insignificant.



Electric Lights and Electric Fans without Smoke, Heat or Danger from Fire. Each Car carries its Own Lighting Apparatus.

SEND FOR ILLUSTRATED PAMPHLET.

Consolidated Railway Electric Lighting & Equipment Co.,

100 BROADWAY, NEW YORK.

J. L. WATSON, Secretary and Treasurer. JNO. T. DICKINSON, General Agent.
JNO. N. ABBOTT, Vice-President and General Manager.

STANDARD TOOL AND MACHINE CO.,

WILMINGTON, DELAWARE.

Steel Screw Punches. Standard and Special Punches and Dies.
Standard and Special Roller Tube Expanders.
Machinists' Combination and Pipe Vises.
Chain Belting and Sprockets.

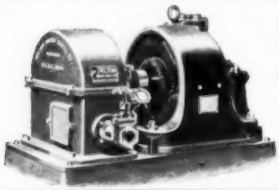
STANDARD DROP FORGINGS SPECIAL

WRITE FOR CATALOGUE AND DISCOUNTS.

SEND SPECIFICATIONS AND GET OUR PRICES.

KEYSTONE DROP FORGE WORKS, Philadelphia, Pa.

Please mention The Engineering Magazine when you write.



200,000 H. P.

developed by **Pelton Wheels**

Operating Electric Transmission Plants alone. Applicable to any class machinery. Send for Illustrated Catalogue.

THE PELTON WATER WHEEL CO.,

127 Main St , San Francisco, Cal. | 143 Liberty St., New York, N. Y.

QUIMBY SCREW PUMPS,
POWER PUMPS AND ELECTRIC PUMPS.

NO VALVES. NO PACKING. NO PULSATION.

Trade QUIMBY Mark. WILLIAM E. QUIMBY, Inc.,

Send for Catalogue. Washington Life Bldg., 86 Liberty St., New York.

WHEN DURABILITY is considered
WARREN'S ANCHOR BRAND ROOFING is
The Most ECONOMICAL Composition Roofing in the World. It is made
from NATURAL ASPHALT. NO COAL TAR.
Write for Particulars and Specifications
WARREN CHEM. and MFG. CO. Roofing Dept 81 Fulton St. New York

By far the most important book we ever have made is ready; sixteen lines of new tools and parts and thirteen additions to established ones. It has "business value." Call it "Wrench Book H."

J. H. Williams & Co.

Brooklyn, - - New York.

STERLING EXTRA INSULATING VARNISH.

Sterling Extra Black Finishing Varnish.
Sterling Black Air Drying Varnish.
Sterling Black Core Plate Varnish.

THE STERLING VARNISH CO., 95 Colmore Row, Birmingham, England. | THE STERLING VARNISH CO., Times Building, Pittsburgh, Pa., U. S. A.

"1793" Vermilion

Retains its brightness. Will not turn black or fade

Painted sample for Exposure Test on application.

HARRISON BROS. & CO., Inc.,

White Lead, Colors, Paints, Varnishes and Chemicals,

36th ST. AND GRAYS FERRY ROAD, PHILADELPHIA. | 27 LAKE STREET, CHICAGO. | 117 FULTON STREET, NEW YORK. | 72 BROAD ST. BOSTON.

Please mention The Engineering Magazine when you write.

INDEX TO ADVERTISEMENTS.

Adams Co..... 52
Aitchison Perforated Metal Co., Robt. 90
Albree Iron Wks., Chester B. 38
Allen & Son, Otis..... 108
Allis-Chalmers Co.....06-88
Alteneder & Sons, Theo.... 31
American Blower Co..... 70
American Bridge Co..... 107
American Cement Co..... 106
Am. Diamond Rock Drill Co. 87
Amer. District Steam Co... 73
American Engine Co..... 60
American Engineering Wks 92
American Gas Furnace Co.. 4
American Locomotive Works 108
American Manufacturing Co. 2
American Ordnance Co.... 75
Am. Tool & Machine Co... 110
American Tool Works Co.. 2
American Turret Lathe Co. 44
American Watchman's Time Detector Co. 81
American Well Works..... 100
Armstrong Mfg. Co..... 46
Asphalt Rubber Paint Co.. 106
Ashton Valve Co..... 7
Ashworth, Daniel 27
Ass'n Engineering Societies 31
Atchison, Topeka & Santa Fe R'way System..... 30
Atlantic Works 73
Atlantic, Gulf & Pacific Co. 21
Atlas Portland Cement Co.. 7
Aultman Co..... 97
Austin Separator Co..... 69

Babcock & Wilcox Co..... 73
Bacon, Earle C..... 91
Baird & Co., Henry Carey.. 97
Baldwin Locomotive Works. 108
Ball Bearing Co..... 87
Ball Engine Co..... 60
Ball & Wood Co..... 59
Barber Mfg. Co., A. H.... 103
Barnes Co., B. F..... 50
Barnes Co., W. F. & John.. 51
Barnett Co., G. & H..... 2
Baush Machine Tool Co.... 48
Beaman & Smith..... 41
Beckley Perf. Screen Wks.. 86
Bethlehem Fdy. & Mach. Co. 38
Bethlehem Steel Co..... 61
Betts Machine Tool Co..... 42
Bickford Drill & Tool Co... 51
"Big Four" Route..... 31
Bignall & Keeler Mfg. Co.. 46
Bilgram, Hugo 38
Blake Mfg. Co., Geo. F.... 103
Blanton & Co., E. A..... 90
Bogue, Chas. J..... 83
Borden & Selleck Co..... 93
Boston Belting Co..... 76
Boston Blower Co..... 70
Bourse, Philadelphia 4
Brandis Sons Co..... 31
Brewer, W. M..... 26
Bridgeport Brass Co..... 34
Brill, Geo. M..... 27
Bristol Company 34
Broderick & Bascom Rope Co. 94
Brooks & Co., T. H..... 107
Brown Hoisting Mach'y Co. 91
Browning Engineering Co.. —
Brown & Sharpe Mfg Co... 20
Bucyrus Co. 3
Buff & Buff Mfg. Co..... 31
Buffalo Forge Co..... 34
Buhl Malleable Co..... 95
Builders Iron Foundry..... 112
Bullard Machine Tool Co.... 41
Bullock Electric Mfg. Co.. 80
Butler, A. G.....97-101

C & C Electric Co..... 82
Caldwell Co., W. E..... 107
Cameron Steam Pump Works, A. S. 100
Carborundum Co. 50
Carlin's Sons Co., Thos..... 96
Carpenter & Co., Geo. B.... 75
Catlett, Charles 26
Chandler & Taylor Co..... 58
Chicago & Alton Railway Co. 30
Christiana Machine Co..... 104
Cincinnati Milling Mch. Co. —
Clayton Air Compress. Wks. 3
Cleveland Punch & Shear Works Co. 44
Coes Wrench Co..... 40
"Compressed Air" 31
Consolidated R'y Elec Lghtg. & Equipt. Co..... 21
Consol. Safety Valve Co... —
Continental Iron Works.... 110
Contractors' Plant Mfg. Co. 97
Cooper, Hewitt & Co..... 96
Cooper, Madison 27
Cox & Sons Co..... 46
Crane Co. 63-73
Cresson Co., Geo. V..... 71
Crippen, H. D..... 88
Crocker-Wheeler Co..... 57
Crosby Steam Gage & Valve Co. 3
Crumlish Forge Co..... 70
Cutler-Hammer Mfg. Co.... 83

Dallett & Co., Thos. H..... 45
Darling, L. B..... 27
Davis Co., John..... 65
Davis Calyx Drill Co..... 89
Deane Steam Pump Co..... 100
Dearborn Drug & Chem. Wks. 78
Del., Lack. & West. R. R.. 30
Detroit Graphite Mfg. Co.. 34
Diamond Machine Co..... —
Dieterich, C. A..... 31
Dietzgen Co., Eugene..... 31
Direct Separator Co..... 69
Dixon Crucible Co., Joseph. 7
Dodge Mfg. Co..... 75
Durable Wire Rope Co..... 5
Dusedau, W..... 26

Eastern Granite Roofing Co. 107
Eastwood Wire Mfg. Co.... 63
Eastern Machinery Co..... 71
Eddy Electric Mfg. Co..... 79
Electric Vehicle Co..... 85
Entriken, J. C..... 89
Ericsson Telephone Co..... 4
Erie Pump & Engine Co.... 103
Eureka Fire Hose Co..... —
Evans & Co., Victor J..... 31
Exeter Machine Works.... 93

Farr & Farr..... 81
Fay & Egan Co., J. A..... 56
Felt & Tarrant Mfg. Co.... —
Flagg & Co., Stanley G..... 112
Flint & Walling Mfg. Co... 107
Frick Company 58

Gagan, George 27
Garry Iron & Steel Rfg. Co. 91
General Concentrates Co... 8
General Electric Co..... 25
General Incand. Lamp Co.. 81
Goodwin Car Co..... 109
Goubert Mfg. Co..... 69
Green Fuel Economizer Co. 64
Griffing Iron Co., A. A..... 66
Guild & Garrison..... 110

Haines Co., Wm. S..... 65
Hall Steam Pump Co..... 100
Hammond Iron Works..... 73
Harris & Son, Wm..... 92
Harrisburg Fdy. & Mch. Wks. 61
Harrison Bros. & Co., Inc.. 22
Harrison Safety Boiler Wks. 64
Hartford Steam Boiler Inspection & Ins. Co..... 65
Hazard Mfg. Co..... 97
Hendrick Mfg Co., Ltd..... —
Hilles & Jones Co..... 44
Hohmann & Maurer Mfg. Co. 70
Holly Mfg. Co..... 103
Holt & Schober..... 26
Holtzer-Cabot Electric Co.. 33
Hooven, Owens Rentschler Co. 58
Hoppes Mfg. Co..... 75
Howard Clock Co., E..... 66
Howard Iron Works..... 47
Howells Mining Drill Co... 2
Huber & Co., S. V..... 27
Hunt Co., C. W..... 98
Hunt & Co., Robt. W..... 27

Industrial Water Co..... 78
Illinois Central R. R..... 30
Ingersoll-Sergeant Drill Co. 86
International Correspondence Schools 29
Jacobson Machine Mfg. Co.. 71
Jantz & Leist Electric Co.. 79
Jeffrey Mfg. Co..... 93
Jenkins Bros. 112
Jessop & Sons, Wm., Ltd.. 52
Johns Mfg. Co., H. W..... 3
Jones & Lamson Mach. Co.. 49

Kansas University 28
Kelly & Jones Co..... 59
Kelly Island Lime & Tr. Co. 106
Kennedy, Julian 26
Kennedy, Walter 28
Kennedy Valve Mfg. Co.... 63
Kenney Co. ..... —
Kentucky State College.... 28
Keuffel & Esser Co..... 31
Keystone Drop Forge Works 21
Kingsford Fdy. & Mch. Wks. 101
Knowles Steam Pump Works 102
Koppel, Arthur 93
Koven & Brother, L. O..... 105

Lafayette College 29
Laidlaw-Dunn-Gordon Co... 101
Lambert Hoisting Engine Co. 96
Lamond, David 27
Landis Tool Co..... 51
Latrobe Steel Co..... 52
Lawrence Cement Co..... 6
Leffel & Co., James..... 104
Lehigh University 29
Leschen & Sons Rope Co., A. 95
Lidgerwood Mfg. Co..... 111
Lime Steel Casting Co.... 52
Link-Belt Engineering Co.. 99
Long & Allstatter Co..... 45
Lunkenheimer Co. 63

McClure, Son & Co., G. W. 27
McGill University 28
McGowan Co., John H.... 102
McKiernan Drill Co..... 89
Macey Co., Fred..... 32
Manning, Maxwell & Moore 48
Manufacturers' Adv. Bureau 35
Marion Steam Shovel Co... 3
Mason Regulator Co..... 62
Massachu etts Fan Co..... 74
Mass. Inst. of Technology.. 29
Maurer & Son, Henry..... 25
Mayer Elec. Co., M. M.... 81
Meitz, A..... 75
Merrell Mfg. Co..... 46
Merriam, C. & G..... —
Merrill Bros 55
Merritt & Co..... 83
Merwarth Metallic Gskt. Co 66
Michigan College of Mines. 29
Michigan Pipe Co..... 102
Monarch Mfg. Co..... 66
Morse Twist Drill & Mch. Co. 7
Co. 54
Morse, Williams & Co..... 47
Mossberg & Granville Mfg. Monongahela Mfg. Co..... —
Monon Route 32
Morgan Construction Co.... 54
Morris Machine Works.... 101
Mould Co., Henry S..... —

Mugford, A. 32
Mundy, J. S. 97

Narragansett Machine Co... 53
National Fireproofing Co... 106
New Process Rawhide Co... 49
New York Central R. R.... —
New York Continental Jewell Filtration Co. 4
New York Military Academy 28
Niagara Mch. & Tool Wks.. 52
Niles Mine & Mill Sup. Co.. 92
Niles Tool Works Co..... 43
Nitro Powder Co..... 90
Northern Electrical Mfg. Co. 84
Northern Eng'g Works.... 55
Norton Emery Wheel Co... 50
Norwalk Iron Works Co... 86

Ogden & Wallace..... —
Onondaga Dynamo Co..... 83
Orford Copper Co..... 52

Passaic Rolling Mill Co.... 34
Patent Record 31
Pearson, James J..... 27
Pearson Machine Co..... 49
Pelton Water Wheel Co.... 22
Penberthy Injector Co..... 72
Perkins Machine Co..... —
Phila. Pneumatic Tool Co.. 38
Phillips Mine & Mill Sup. Co. 87
Phosphor Bronze Smelt. Co. 52
Pittsburg Gage & Supply Co. 62
Pittsburg Valve, Fdy. & Construction Co. 67
Pneumatic Engineering Co. 102
Pond Machine Tool Co.... 43
Poole & Son Co., R..... 47
Porter Co., H. K..... 108
Power Specialty Co..... —
Pratt Institute 28
Pratt & Whitney Mfg. Co.. 39
Prentice Bros. Co..... 40
Purdue University 29
Pulsometer Steam Pump Co. 101

Quaker City Rubber Co.... 74
Queen & Co., Inc..... 7
Quimby, Wm. E..... 22
Quint, A. D..... 47
Rand Drill Co..... 87

Reeves & Son, Paul S..... 52
Redfield, C. L..... 27
Rensselaer Polytechnic Inst. 28
Replogle Governor Works.. 104
Reynolds, Sidney F..... 26
Rider-Ericsson Engine Co.. 102
Riter-Conley Mfg. Co..... 25
Rivett-Dock Co. 45
Robins Conveying Belt Co.. 94
Rockwell & Rupel Co..... 8
Rockwell Engineering Co.. 63
Rockwood Mfg. Co..... 79
Roebling's Sons Co., John A. 94
Roelker, H. B..... 27
Roessler & Hasslacher Chemical Co. 89
Rose Polytechnic Institute.. 28
Ross Valve Co..... 68

Schäffer & Budenberg..... 71
Schieren & Co., Chas. A.... 77
Schureman & Hayden..... 82
Sellers & Co., Wm..... 51
Shaw Electric Crane Co.... —
Shaw-Walker Co. 32
Sheffield Scientific School.. 29
Skinner Chuck Co..... 8
Slocomb & Co., F. F..... 39
Smidth & Co., F. L..... 90
Smith & Aldrich..... 28
Smith Co, H. B..... 106
Smith Machine Co., H. B.. 56
Smith Co., S. Morgan..... 104
Smoke Prevention Co. of America 72
Snow Steam Pump Works.. 105
Southwark Fdy. & Mch. Co. 58
Speidel, J. G..... 47
Sprague Electric Co..... 83
Standard Tool & Machine Co. 21
Standard Water Meter Co.. 101
Stanley Electric Mfg. Co... 84
Star Brass Mfg. Co..... 67
Star Drilling Machine Co... 88
Stephenson Mfg. Co..... 74
Sterling Varnish Co..... 22
Stevens Inst. of Technology 29
Stewart Heater Co..... 68
Stilwell-Bierce & Smith-Vaile Co. 56
Stirling Co. 112
Storrs, Arthur Hovey..... 27
Stow Flexible Shaft Co.... 51
Stow Manufacturing Co.... 81
Strieby & Foot Co..... 54
Struthers, Wells & Co..... 58
Sturtevant Co., B. F..... 68
Sturtevant Mill Co..... 89

Tennesse University 28
Thayer School of Civil Eng'g 29
Trenton Iron Co..... 96
Triumph Electric Co..... 24
Troy Nickel Works..... 59

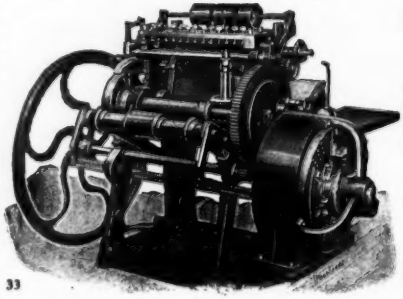
U. S Cast Iron Pipe & Foundry Co. 103
U. S. Electro-Galvanizing Co. 56
U. S. Gutta Percha Paint Co. 46
U. S. Metallic Packing Co.. 8

Van Slooten, Wm..... 26
Vulcan Iron Works Co. (Toledo) 4
Vulcan Iron Works (Wilkesbarre) 86

Walworth Mfg. Co..... 7
Warren Chem. and Mfg. Co. 22
Watson-Stillman Co..... 105
Watson & McDaniel Co.... 66
Watt Mining Car Wheel Co. 91
Webster Camp & Lane Machine Co. 90
Webster & Co., Warren.... 67
Wefugo Company 78
Wellman-Seaver Engng. Co. 26
Western Electric Co..... 81
Westinghouse Air Brake Co. 36
Westinghouse, Church, Kerr & Co. 37
Westinghouse Electric & Mfg. Co. 37
Westinghouse Machine Co.. 37
Weston Electric. Instmt. Co. 110
Whitcomb Mfg. Co..... 40
Whiting Fdy. Equipt. Co... 54
Williams Bros. 103
Williams Gauge Co..... 70
Williams & Co., J. H..... 22
Williams, White & Co..... 55
Wilson, W. A..... 52
Winters, O. E..... 27
Wisconsin University 29
Wood & Co, R. D..... 105
Worcester Polytechnic Inst. 29
Worthington, Henry R..... 105
Wyman & Gordon..... 112

Yawman & Erbe Mfg. Co... 33
Young Mfg. Co., W. C.... 40

MOTORS OF ALL KINDS,



33

ELECTRIC DRIVEN PRINTING PRESS.

BELTED, DIRECT-CONNECTED, GEARED.

No other method of applying power to Machine Tools, Line Shafts, Punching Presses, etc., equals the Electric Motor for convenience, efficiency and economy in their operation. OUR MOTORS are of the highest possible grade. We also make a complete line of

GENERATORS,

either belted or direct connected.

WRITE FOR OUR NEW CATALOGUE.

The Triumph Electric Co.,

CINCINNATI, O. U. S. A.

The General Electric Company's

GENERATORS OF ALL SIZES.

Direct-Connected or belt driven with steam or hydraulic power.

MOTORS OF EVERY KIND.

For railway or street car service, mills, factories, machine shops, pumps, ventilation and general mining use.

ARC AND INCANDESCENT LAMPS.

On direct or alternating current circuits for street, store and house illumination.

ELECTRICAL SUPPLIES.

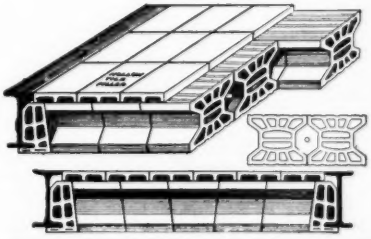
For the complete equipment of lighting, railway, power and transmission installations.

GENERAL OFFICE: SCHENECTADY, N. Y.
NEW YORK OFFICE: 44 BROAD STREET.

Sales offices in all large cities.

HENRY MAURER & SON,

Established 1856.



MANUFACTURERS OF

Fire-Proof Building Material

Of every description. Hollow Brick, made of Clay, for Flat Arches, Petitions, Furring, etc. Porous Terra Cotta, Fire Brick, etc., etc. : : : :

Office and Depot, 420 EAST 23d ST., NEW YORK.

WORKS, MAURER, N. J.

Send for Catalogues on "Fireproofing" and "Fire-Brick."

STEEL CONSTRUCTION

IN ALL BRANCHES

BUILDINGS DESIGNED AND ERECTED IN ALL PARTS OF THE WORLD.

Roof Frames, Trusses and Girders,
Blast Furnaces and Steel Works,
Cupolas, Ladles, Converters,
Boilers, Tanks and Heavy Plate Work,
Gas Holders, Purifiers, etc.
Open Hearth Furnace Casings,
Chimneys, Riveted Pipe, Corrugated Iron.

RITER-CONLEY MFG. CO., PITTSBURGH, PA., U. S. A.

New York Office--39-41 Cortlandt Street.

Please mention The Engineering Magazine when you write.

Professional Directory

JULIAN KENNEDY, Engineer,
Pittsburg, Pa., U. S. A.

MACHINERY AND PLANT FOR THE
ECONOMICAL PRODUCTION
OF IRON AND STEEL.

...CONSULTATIONS AND EXPERT WORK IN....
GENERAL ENGINEERING PRACTICE.

CABLE ADDRESS: "ENGINEER, PITTSBURG."

ESTABLISHED 1891. CABLE ADDRESS, "CATLETT." MCNEILL CODE.
CHARLES CATLETT,
FORMERLY OF THE UNITED STATES GEOLOGICAL SURVEY LABORATORY.
CHEMIST AND GEOLOGIST.
EXAMINATION AND REPORT ON DEVELOPED AND UNDEVELOPED PROPERTIES.
STAUNTON, VA.

WM. VAN SLOOTEN, C. E.,
MINING ENGINEER & METALLURGIST
MEMBER AM. INST. MINING ENGINEERS.
Am. S. Civil Engineers, North of England Institute Mining and Mechanical Engineers. The Institution of Mining and Metallurgy, etc.
35 WALL STREET, - NEW YORK.
CABLE ADDRESS, YADOPLATA.

GEORGE R. HOLT. FRED. SCHOBER.
HOLT & SCHOBER,
ENGINEERS AND ARCHITECTS,
NO. 378 BOURSE, PHILADELPHIA.
Cold Storage and Ice Making. Mill and Factory Construction—complete plans. Reports. Expert Services. Consultations.

SYDNEY F. REYNOLDS,
TORREY, PA., U. S. A.
Architect, Builder, Draughtsman, Electrical, Mechanical, Mining and Civil Engineer.
Correspondence Solicited. Work Guaranteed.

WILLIAM M. BREWER, M. E.
MINING ENGINEER,
MEMBER NORTH OF ENGLAND INSTITUTE,
MOLSON'S BANK BUILDING, VANCOUVER, B.C.

W. DUSEDAU,
CONSULTING & CONTRACTING ENGINEER,
529 MINING EXCHANGE BUILDING,
DENVER, COLO.,
Patent Wire Ropeways, Hoisting and Conveying Cableways. All work Guaranteed. Send for particulars.

THE WELLMAN-SEAVER ENGINEERING COMPANY,
CONSULTING AND CONTRACTING ENGINEERS
AND METALLURGISTS.
CLEVELAND, OHIO, U. S. A.
Wellman Open Hearth Furnaces and Charging Apparatus. Blast Furnace and Rolling Mill Construction.
SOLE MANUFACTURERS OF FORTER WATER SEALED REVERSIBLE VALVES.

Professional Directory

G. W. McCLURE, SON & CO., ENGINEERS AND CONTRACTORS.
Blast Furnace Construction, Fire Brick Hot Blast Stoves, Open Hearth and Heating Furnaces.
SMITH BLOCK, PITTSBURG, PA.

S. V. HUBER & CO., CONSULTING ENGINEERS,
ROOMS 700-708 FERGUSON BUILDING,
TELEPHONE, PGH. 3356. PITTSBURGH, PA.
Consulting and Constructing Engineers for the Republic Iron and Steel Co.
Blast Furnaces, Bessemer and Open Hearth Steel Works, Continuous Mills, Hoop Mills, Merchant Mills, Automatic Mill Tables, Labor Saving Devices relating to Rolling Mills, Steam and Hydraulic Machinery.

L. B. DARLING,
METALLURGIST, CHEMIST & ASSAYER,
PRINCIPAL OF THE NEW ENGLAND MINING BUREAU,
79 SABIN ST., PROVIDENCE, R. I.
Determines best methods of treating ores; furnishes machinery at manufacturers' prices—complete outfits, including power; works parcels of ore by all processes, and negotiates the sale of mines.

Ask for
rates on Professional Cards on this page.

DANIEL ASHWORTH,
MECHANICAL CONSULTING ENGINEER AND STEAM EXPERT,
515 PENN AVE., PITTSBURGH, PA.
Steam and Transmission of Power a Specialty.

CABLE ADDRESS, ENGINEER, NEW YORK.
JAMES J. PEARSON,
CONSULTING ENGINEER AND VALUER,
40 WALL ST., NEW YORK.
Any kind or class of Machinery, Plant or Power-using Industry surveyed for efficiency or appraised for value. Industrial Investigations, and Reports.

MADISON COOPER,
REFRIGERATING ENGINEER AND ARCHITECT,
MINNEAPOLIS, MINN.
The Complete Design of Cold Storage and Refrigerating Installations.
Consultation and Expert Services.

DAVID LAMOND,
CONTRACTING ENGINEER,
710 FERGUSON BLOCK, THIRD AVENUE,
PITTSBURGH, PA.
Blast Furnace Construction. Patentee Central Combustion Chamber 4 Pass Stove.
Agent for C. H. Foote Patent 2 and 4 Pass Fire Brick Stove.

ARTHUR HOVEY STORRS, C.E.,
SCRANTON, PA.
Examination and Reports on Coal Properties.
Designing of Colliery Plants.

JNO. J. CONE, ROBERT W. HUNT, JAS. C. HALLSTED,
A. W. FIEHO, D. W. M'NAUGHER,
ROBERT W. HUNT & CO.
Bureau of Inspection, Tests and Consultation,
71 BROADWAY, NEW YORK, 1121 THE ROOKERY, CHICAGO,
MONONGAHELA BANK BLDG., PITTSBURG.
Inspection of Rails and Fastenings, Cars, Locomotives, Pipe, etc. Bridges, Buildings and other Structures.
Chemical and Physical Laboratories.
Reports and Estimates on Properties and Processes.

O. E WINTERS & GEO. GAGAN,
CHEMISTS AND ASSAYERS,
Complete Analysis Given.
1227 SUMMER ST., PHILADELPHIA, PA.

GEO. M. BRILL, M. E.,
CONSULTING ENGINEER,
1143-4 MARQUETTE BLDG., CHICAGO, ILL.
Steam, Gas and Electric Plants, Shops and Manufactories, Cold Storage and Refrigeration.

C. L. REDFIELD, M. E.,
DESIGNER OF MACHINERY,
EXPERT IN PATENT CAUSES,
269 DEARBORN ST., CHICAGO, ILL.

H. B. ROELKER,
CONSULTING, EXPERT & CONSTRUCTING MECHANICAL ENGINEER,
41 MAIDEN LANE, NEW YORK.
Factory and Marine Work, Refrigerating and Pumping Machinery. Designer and manufacturer of Screw Propellers. THE ALLEN Dense Air Ice Machine for Steam Vessels.

Professional Directory

SMITH & ALDRICH, CONSULTING ENGINEERS,
Civil, Municipal, Hydraulic, Electrical and Mechanical Engineering.
101-103 MAIL AND EMPIRE BUILDING, TORONTO, CANADA.
CECIL B. SMITH, Ma. E, *Mem. Can. Soc C. E.*
WM. S. ALDRICH, M. E., *Mem. Am. Soc. M. E., Mem. Am. Inst. E. E.*

WALTER KENNEDY,

PITTSBURG, PA.

Contracting and Consulting Engineer.

BLAST FURNACES. ROLLING MILLS.

Bessemer and Open Hearth Steel Works, Etc.

Schools and Colleges

University of Tennessee

KNOXVILLE.

Four years courses in Electrical, Civil, Mechanical and Chemical Engineering. Well equipped laboratories and shops. Climate excellent. Expenses low. For Catalogue and detailed information address
REGISTRAR, Knoxville, Tenn.

Send ten cents in stamps for Vest Pocket Manual for Engineers.

University of Kansas.

SCHOOL OF ENGINEERING.

Courses in Civil, Mechanical, Electrical, Mining and Chemical Engineering. Well equipped science and engineering laboratories. New shops and power plants. New physical and chemical buildings. Teachers with professional experience. Tuition free to Kansas students. Nominal fee for others. For catalogue or information, address
F. O. MARVIN, Dean, Lawrence, Kansas.

New York Military Academy,

CORNWALL-ON-HUDSON, N. Y.

Prepares especially for the great Technical Schools. Practical Courses in Science, Language, Manual Training and Drawing.

For Catalogues apply to the Superintendent.

PRATT INSTITUTE,

Brooklyn, N. Y.

TWO YEAR COURSES IN APPLIED ELECTRICITY AND IN STEAM AND MACHINE DESIGN.

Modernly equipped *Shops*, and excellent *Laboratory* facilities in Physics, Chemistry, Electricity, Steam, Strength of Materials and Hydraulics. Write for catalogue and particulars.

McGill University, Montreal.

Courses in Civil, Mechanical, and Electrical Engineering; Mining Engineering and Metallurgy; Chemistry; Architecture. Also full courses in Arts, Law, Medicine, and Veterinary Science.

For further information and for the University Calendar, address
W. VAUGHAN, Registrar.

State College of Kentucky.

Comprising—
SCHOOL OF MECHANICAL ENGINEERING,
SCHOOL OF ELECTRICAL ENGINEERING,
SCHOOL OF CIVIL ENGINEERING.

Address,
JAMES K. PATTERSON, President,
Lexington, Ky.

The Rose Polytechnic Institute,

TERRE HAUTE, INDIANA.

A College of Engineering. Courses in Mechanical, Electrical and Civil Engineering, Chemistry and Architecture. Extensive shops and Laboratories. Expenses low. Nineteenth year.
For catalogue, address
C. L. MEES, President.

Rensselaer Polytechnic Institute, Troy, N. Y.

ESTABLISHED 1824.
A SCHOOL OF ENGINEERING

Local examinations provided for. Send for a Catalogue.

Schools and Colleges

Thayer School of Civil Engineering.

DARTMOUTH COLLEGE, HANOVER, N. H.

Essentially a post-graduate course of two years, requiring adequate preparation in mathematics —including calculus and descriptive geometry— physics, chemistry and astronomy. Established 1871. Small classes; constant contact with instructors. Degree of Civil Engineer. For Catalogue, program of requirements, etc., address,

Prof. ROBERT FLETCHER, Director.

Massachusetts Institute of Technology,

BOSTON.

HENRY S. PRITCHETT, Ph. D., LL. D., President.

The Institute offers four-year courses in **Civil, Mechanical, Mining, Electrical, Chemical and Sanitary Engineering;** in **Architecture, Metallurgy, Chemistry, Physics, Biology, Geology;** in **Naval Architecture and in General Studies.**

Catalogues and detailed circulars of information will be sent free on application.

H. W. TYLER, Secretary, 491 Boylston St., Boston, Mass.

The Worcester Polytechnic Institute,

WORCESTER, MASS.

T. C. MENDENHALL, PH. D., LL.D., President.

Courses of Study in Mechanical, Civil and Electrical Engineering, Chemistry and General Science. New and extensive laboratories in Engineering, Electricity, Physics and General and Industrial Chemistry. Special facilities in Steam and Hydraulics. 200 page catalogue, showing positions filled by graduates, *mailed free.*

Address J. K. MARSHALL, Registrar.

Sheffield Scientific School of Yale University,

NEW HAVEN, CONN.

Courses in Civil, Electrical and Mechanical Engineering; in Chemistry, Pure and Applied; in Botany, Zoology, Mineralogy and Geology; in studies preparatory to Mining and Metallurgy; in Biology, with special reference to preparation for a Medical Course; and in General Scientific Studies, with English, French, Spanish and German, Political Economy, History, etc. *For programme address.*

Professor RUSSELL H. CHITTENDEN, Director.

Our students succeed because they use I. C. S. textbooks.

Steam Engineering

A course in Steam Engineering enabling students to pass examinations and secure better positions. Includes operation of dynamos and motors.

We teach by mail, Mechanical, Steam, Electrical, Civil and Mining Engineering; Shop and Foundry Practice; Mechanical Drawing; Architecture; Plumbing; Sheet Metal Work; Chemistry; Ornamental Design; Lettering; Bookkeeping; Stenography; Teaching; English Branches; Locomotive Running; Electrotherapeutics.

When writing state subject in which interested.

taught by mail.

International Correspondence Schools, Box 818, Scranton, Pa.

Stevens Institute of Technology

provides a course of study of four years' duration, covering all that appertains to the profession of a

MECHANICAL ENGINEER.

Complete Mechanical, Electrical, Physical and Chemical Laboratories. For particulars, address Stevens Institute of Technology, Hoboken, N. J.

Lehigh University,

SOUTH BETHLEHEM, PA.

The University offers courses in General Literature, in Civil, Mechanical, Mining, and Electrical Engineering, in Metallurgy, Analytical Chemistry, Geology, and Physics.

For further information, for Registers of the University, and for descriptive circulars of the different courses, address

THE REGISTRAR OF LEHIGH UNIVERSITY, South Bethlehem, Pa.

Lafayette College,

EASTON, PA.

Thoroughly equipped technical courses in

CIVIL, MINING AND ELECTRICAL ENGINEERING AND CHEMISTRY.

For Catalogues address

THE REGISTRAR.

Michigan College of Mines,

HOUGHTON, MICH.

An Engineering School with unique location, giving it unusual facilities. Distinctive methods of instruction. Special courses given. All work in charge of widely experienced men. Catalogue giving list of graduates and their occupations on application. Address

F. W. McNAIR, President.

University of Wisconsin.

All the engineering courses, besides a General Course, with liberal electives for persons not expecting to follow engineering as a profession, in *Engineering Science and Practice.* Athletic advantages unexcelled. Fees moderate. "Madison has the most magnificent site of any inland town in America," and it is as healthful as it is beautiful. Address

J. B. JOHNSON, Dean College of Engineering, Madison, Wis.

Purdue University,

LAFAYETTE, IND.

Courses in Civil Engineering, Electrical Engineering, Mechanical Engineering.

EXTENSIVE LABORATORIES. FINE EQUIPMENTS.

Catalogue sent on application.

Consider this:

Your factory may be perfectly constructed, thoroughly equipped and ably managed, but unless judiciously located perfect construction, equipment and management will not enable you to earn dividends. We are glad to report on available and favorable locations open to all classes of industries on the lines of our System in Illinois, Missouri, Kansas, Oklahoma, Indian Territory, Texas, Colorado, New Mexico, Arizona and California.

JAMES A. DAVIS,
Industrial Commissioner,
Atchison, Topeka & Santa Fe R'wy System,
CHICAGO.

AMERICA'S MOST POPULAR RAILWAY
CHICAGO AND ALTON
PERFECT PASSENGER SERVICE

BETWEEN

CHICAGO AND KANSAS CITY.
CHICAGO AND ST. LOUIS.
CHICAGO AND PEORIA.
ST. LOUIS AND KANSAS CITY.

THROUGH PULLMAN SERVICE BETWEEN CHICAGO AND

HOT SPRINGS, Ark., DENVER, Colo.
TEXAS, FLORIDA, UTAH,
CALIFORNIA AND OREGON.

IF YOU ARE CONTEMPLATING A TRIP, ANY PORTION OF WHICH CAN BE MADE OVER THE CHICAGO & ALTON, IT WILL PAY YOU TO WRITE TO THE UNDERSIGNED FOR RATES, MAPS, TIME-TABLES, ETC.

GEO. J. CHARLTON,
GENERAL PASSENGER AGENT,
CHICAGO, ILL.

OF INTEREST TO
MANUFACTURERS

Write for a copy of pamphlet just issued by the

Illinois Central R.R. COMPANY

giving reliable information concerning nearly 200 desirable locations for industries, and entitled

INDUSTRIAL SITES IN TEN STATES.

ADDRESS GEORGE C. POWER,
Industrial Commissioner, Illinois Central Railroad,
Room 506 Central Station, CHICAGO, ILL.

INDUSTRIAL OPPORTUNITIES

Containing Detailed Information Regarding

RAW MATERIALS, SHIPPING FACILITIES, RATE OF TAXATION, COST OF LABOR, SOURCES AND PRICE OF POWER, VALUE OF LANDS SUITABLE FOR MANUFACTURING SITES AND SPECIAL INDUCEMENTS EXISTING ALONG THE LINES OF THE . . . . . .

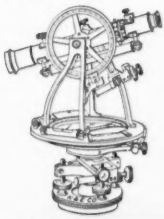
Lackawanna Railroad

B. D. CALDWELL, Traffic Manager
WILLIAM B. HUNTER, Industrial Agent.

General Offices:
26 Exchange Place, New York City.

Please mention The Engineering Magazine when you write.

KEUFFEL & ESSER CO.,



Surveying Instruments,
Drawing Materials,
NEW YORK.

BRANCHES:
Chicago. St. Louis,
San Francisco.

Write for Illustrated Catalogue.

EUGENE DIETZGEN CO.

Chicago: 181 Monroe St. New York: 149-151 Fifth Ave.

ENGINEERING AND DRAWING INSTRUMENTS

Profile, Tracing, Drawing and Blue Print Papers, Drawing Boards, Triangles, T Squares, Scales, etc. Send for our new 224-page ILLUSTRATED CATALOGUE.

THE BRANDIS SONS CO.,

Surveying and Engineering Instruments,
754 to 756 LEXINGTON AVENUE,
Catalogues sent on application. BROOKLYN, N.Y.

C. A. DIETERICH,
COUNSELOR AT LAW,
SOLICITOR OF U. S. AND FOREIGN PATENTS,
229 BROADWAY, NEW YORK CITY, N. Y.

Litigation affecting Letters Patent, etc.
Special attention devoted to inventions relating to
STEAM ENGINEERING.

CASH for acceptable ideas. State if patented. THE PATENT RECORD, Baltimore, Md.
Subscription price of the PATENT RECORD $1.00 per annum. Samples free.

Formerly of BUFF & BERGER

Buff & Buff,

MFG. CO.
Engineering, Surveying, Mining Instruments
Catalogue No. 22 gratis.
Jamaica Plain Sta., Boston, Mass.

KNICKERBOCKER SPECIAL

—AND—

South-Western Limited,

Famous Trains Between

BOSTON, NEW YORK, WASHINGTON, *CINCINNATI, CHICAGO, ST. LOUIS,*

VIA

Big Four Route

AND

NEW YORK CENTRAL, BOSTON & ALBANY, CHESAPEAKE & OHIO.

Cafe, Library, Dining and Sleeping Cars.

W. J. LYNCH, Genl. Pass. and Tkt. Agt. W. P. DEPPE, Asst. G. P. and T. A. CINCINNATI, O.

PATENTS GUARANTEED

Our fee returned if we fail. Any one sending sketch and description of any invention will promptly receive our opinion free concerning the patentability of same. "How to Obtain a Patent" sent upon request. Patents secured through us advertised for sale at our expense.

Patents taken out through us receive *special notice*, without charge, in THE PATENT RECORD, an illustrated and widely circulated journal, consulted by Manufacturers and Investors.

Send for sample copy **FREE.** Address,

VICTOR J. EVANS & CO.
(*Patent Attorneys,*)
Evans Building, WASHINGTON, D. C

Subaqueous Tunnels for Gas Mains. By W. W. CUMMINGS. Discussion by Howard A. Carson, C. M. Saville, Robert A. Shaller and author, of Boston Society of Civil Engineers.

Flood Heights in the Lower Mississippi. By LINUS W. BROWN. Discussion by H. B. Richardson, B. M. Harrod, Wm. Joseph Hardee, Sydney F. Lewis and author, of Louisiana Eng. Society.

Journal of the Association of Engineering Societies.

30 cents per Copy. $3.00 per Annum. JUNE, 1901. JOHN C. TRAUTWINE, JR., SECRETARY, 257 S. 4th St., Philadelphia

COMPRESSED AIR

A Compendium of Compressed Air Information.

Published monthly. Now in its sixth year. The only periodical devoted exclusively to this subject. It is both theoretical and practical, progressive and up-to-date. Subscription $1.00 a year. Foreign, $1.50. Send for sample copy.
COMPRESSED AIR, - 26 Cortlandt St., NEW YORK.

"BUSINESS SYSTEM"

is the title of our 64-page book illustrating and explaining model business methods used by our largest and most successful business houses—it is free upon request.

IT GATHERS
ARRANGES
CLASSIFIES
INDEXES
every class of business, Records on Lists—it

Increases Profits
and
Reduces Expenses

"Macey" Patent SIDE-LOCKED CARDS
require no unsightly and wasteful holes to mar the writing surface.

YOUR CHOICE
of *three* distinct card-locking devices.

$1.25 AND UPWARD
Buys a complete **"Macey" Card System**

On Approval. We ship every article **"On Approval,"** to be returned *at our expense* if not found positively *the best* ever sold at so low a price.

We Prepay Freight to all points east of the Mississippi and north of Tennessee. (Points beyond on an equal basis.)

Write for our complete Catalogue No. "D D 5."

THE FRED MACEY CO., Ltd., Grand Rapids, Mich.
Branches:
NEW YORK, *293-295 Broadway.* BOSTON, *17 Federal St.* PHILADELPHIA, *1413 Chestnut St.*
CHICAGO, *New York Life Building.*

File data right

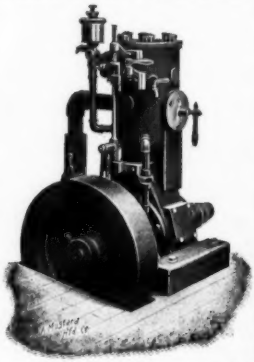
The next best thing to knowing a thing is to know where to find it when wanted. The SHAW-WALKER Card System enables the engineer to put away in an instant any data he thinks he may need again, and in such a way that it can be found in another instant—even years after.

Write now for catalog

Or better still, send us eight 2-cent stamps and receive six months' subscription to "SYSTEM." It teaches and encourages system. It illustrates and explains methods actually in use by successful business and professional men.

THE SHAW-WALKER CO., Muskegon, Mich.
Trial outfit—Case, cards, indexes, complete, $1.00, prepaid.

MUGFORD'S ENGRAVINGS FOR COMMERCIAL PRINTING.



HALF TONES. WOODCUTS AND ELECTROTYPES.

THERE IS AN INCREASING DEMAND FOR OUR CUTS

OBSERVE THE ADDRESS
177 ASYLUM ST. HARTFORD, CONN. U.S.A.
NEW YORK OFFICE 120 LIBERTY ST.

THE MONON ROUTE
CHICAGO INDIANAPOLIS & LOUISVILLE RAILWAY

Is the Best Route between

Chicago, Indianapolis, Cincinnati, Louisville and the South:

* * *

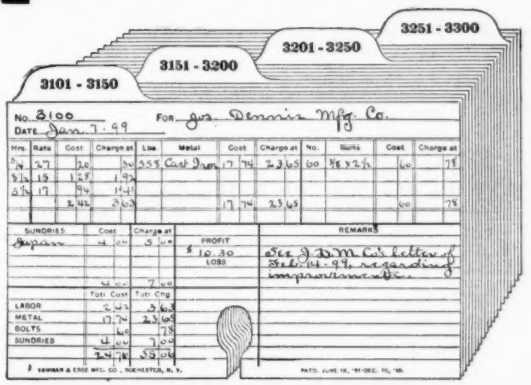
SOLID VESTIBULED TRAINS DAILY.

* * *

CITY TICKET OFFICE,
232 CLARK ST., CHICAGO.

FRANK J. REED, Gen'l Pass. Agent.
CHAS. H. ROCKWELL, Traffic Mgr. W. H. McDOEL, Pres. and Gen'l Mgr.

Cost Records, and records



and indexes of all kinds are best kept by the . . . . . .

"Y & E" Card System.

The illustration shows how we adapted it to suit one business.

☞ We can adapt it to any requirements of *your* business.

Send for Cat. 7-M and write us particulars.

New York, 300 Broadway. Chicago, 138 Wabash Avenue. San Francisco, 20 New Montgomery Street.

Yawman & Erbe Mfg. Company,

ROCHESTER, N. Y.

Philadelphia, Boston, St. Louis, Pittsburg, Cleveland, Baltimore.

Constant Supervision of Your Factory

NIGHT ....AND.... DAY

H.-C. Watch Clocks.

Give an accurate record of your watchman's faithfulness.

Record is perfectly indelible and cannot be tampered with.

Operated either by magnetos or batteries

ABSOLUTELY RELIABLE..... Thousands in Constant Use.

Send for Catalogue No. 27 M.

Ness Automatic Telephones

Provide means for instant communications with any of your employees without your leaving your desk or calling them from their departments.

You make your own connections; no central is required.

Switch is automatically disconnected and returned to its home point on replacing the receiver.

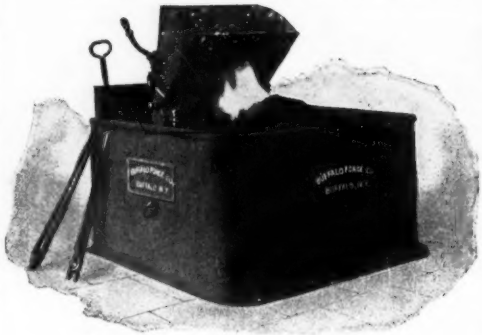
A PERFECT TELEPHONE SYSTEM THAT WILL "STAY PUT."

Send for booklet N. P. and list of firms using these instruments.

The Holtzer-Cabot Electric Co.,

CHICAGO OFFICE: No. 397 Dearborn St. BOSTON (BROOKLINE), MASS.

Buffalo Down-Draft Forges typify



Type used in the leading railroad shops.
Complete lines of Down-Draft Forges for all Purposes.

SEND FOR OUR ILLUSTRATED CATALOGUE.

Advanced Practice in the Smithy

They remove smoke completely.
They prevent escape of gases.
They obviate overhead pipes.
They are indestructible.

Originated and Exclusively Controlled by patents of this Company.

Buffalo Forge Co.,

BUFFALO, N. Y.

N. Y. Office: 45 Broadway.

THE PASSAIC ROLLING MILL CO.

Main Office & Works: Paterson, N. J.

W. O. FAYERWEATHER, Pres. & Treas. GEO. H. BLAKFLEY., Ch. Eng. JOHN K. COOKE, Gen. Mgr.

Design, Manufacture and Construct all kinds of Iron and Steel Work for

BRIDGES AND BUILDINGS,

Roofs, Power Stations, Train Sheds, Railway and Highway Bridges and Viaducts, Standard Railroad Turntables, and Structural Steel Work for Buildings. Plans and Specifications furnished upon application.

MANUFACTURERS OF HIGH GRADE IRON, OPEN HEARTH STEEL AND STRUCTURAL SHAPES.

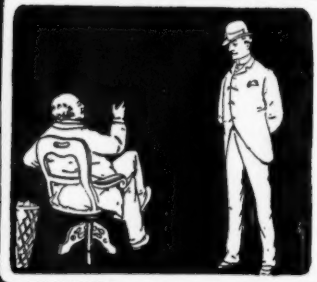
"PHONO-ELECTRIC"

"IT'S TOUGH."

The most reliable wire for Trolley, Telephone and Telegraph lines.

BRIDGEPORT BRASS CO.

19 Murray Street, - - - - - - New York.



PAINT TALKS.

An inert pigment offers the best protection. May we s nd you booklet showing wherein

"SUPERIOR GRAPHITE PAINT"

fulfills this requirement of a Structural Steel or Bridge coating.

Manufactured solely by

DETROIT GRAPHITE MFG. CO.,
DETROIT, MICH.
New York. Boston. Chicago.

THE BRISTOL COMPANY,

WATERBURY, CONN.

MANUFACTURERS OF BRISTOL'S RECORDING INSTRUMENTS.

Pressure Gauges, Vacuum Gauges, Thermometers, Ampere Meters, Volt Meters, and Watt Meters. Make continuous Records Day and Night. Fully Guaranteed.

NEW YORK BRANCH: 121 LIBERTY ST.

SILVER MEDAL, PARIS EXPOSITION.

Please mention The Engineering Magazine when you write.

Advertising in the Trade Journals.

WE will be pleased to figure with you on any Newspaper Work or Advertising you may have to do. **Ours is a time, labor and money saving** institution.

Been established over **twenty** years.
Represent over **fifty** of the largest Manufacturers in the United States.

Low Rates and satisfaction guaranteed. Our little book, **Advertising for Profit,** will tell you all about our methods. It is free to interested parties for the asking. Write, telegraph, telephone or call.

Manufacturers' Advertising Bureau,
126 LIBERTY STREET,
BENJ. R. WESTERN, Propr. ... **New York.**

Cable, "WESTERN," New York.
Telephone, "3840 CORTLANDT." The Directory Code.

☞ ***Advertisements inserted in any paper in the world.***

Westinghouse

Friction Draft Gear

Prevents the Breaking of Couplings

Dissipates Heavy Train Shocks

Friction Devices absorb Recoil of Springs

Westinghouse Air Brake Co.

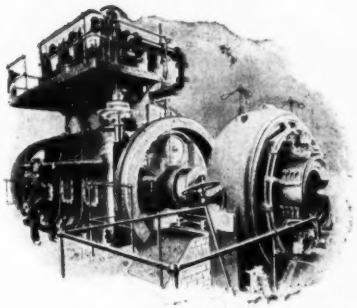
PITTSBURG, PA.

31 G 2

Generators

For Lighting and Power Work.

Westinghouse Generators operate economically and efficiently under all conditions of service.



Universally adopted for service in the best equipped Railway, Lighting and Power Plants.

Westinghouse 400 Kw. Engine Type Generator, Installed.

Westinghouse Electric & Mfg. Co.,

PITTSBURG, PA.

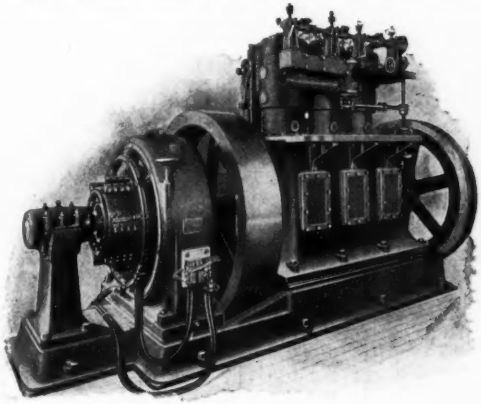
All Principal Cities in U. S. and Canada.

Westinghouse, Church, Kerr & Co.

Engineers.

New York, Chicago, Boston, Pittsburg, Philadelphia, Detroit.

We can furnish plans and specifications for Power Plants of all descriptions.



Steam Turbines, Gas Engines, Steam Engines, Mechanical Stokers, High Pressure Piping, etc., etc.

Westinghouse Gas Engine Generating Set, Installed.

The Westinghouse Machine Co.

31 G 2. Pittsburg—**Manufacturers**—Chicago.

Margins.

Do your profits grow smaller? Then consider this fact:

The difference in cost of work done with our pneumatic tools and with others is often greater than your whole margin of profit.

If this is true, can you afford to use pneumatic tools that are "nearly as good" as the best?

Send for catalogue of our Pneumatic Chipping and Riveting Hammers, Rotary and Piston Drills, Rammers, etc.

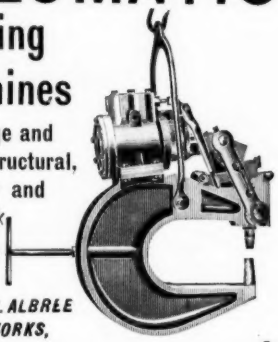
PHILADELPHIA PNEUMATIC TOOL CO.,

1038 RIDGE AVE., PHILADELPHIA.

New York. Chicago. Pittsburgh.

HF

PNEUMATIC Riveting Machines



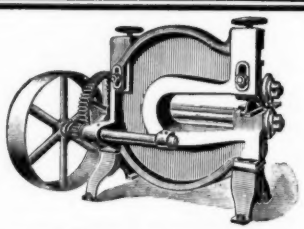
For Bridge and Structural, Boiler and Tank work

Manufactured by

CHESTER B. ALBREE IRON WORKS,

28 Market St., Allegheny, Pa.

Catalogue on Application.



SHEAR-ROTARY.

Cuts Outer Circles.
Cuts Straightaway.

Cuts many times faster than any other type of Shear.

SEND FOR CATALOG.

BETHLEHEM FOUNDRY & MACHINE CO.,

SOUTH BETHLEHEM, PA.

Bevel Gears.....

Cut Theoretically Correct. Special facilities for cutting Worm and Spiral Wheels.

HUGO BILGRAM,

Machinist,

440 N. 12th Street,
PHILADELPHIA, PA

Renshaw Ratchet Drill.

This tool will commend itself wherever used. It is made in two sizes, No. 1 taking drills 1-4 to 1-2 and No. 3 taking drills 1-2 to 1 1-2.

Pratt & Whitney Co.,

HARTFORD, CONN., U. S. A.

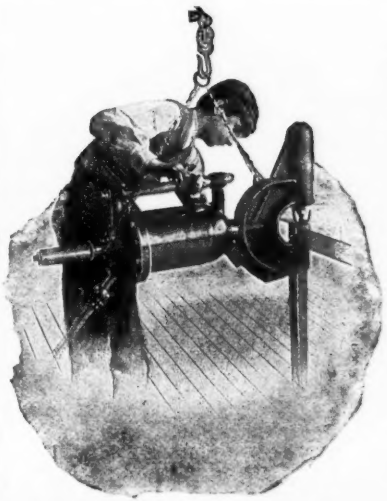
Small Tool Department.

NEW YORK: 136-138 Liberty Street. | **CHICAGO: 42 South Clinton Street.**
BOSTON : 144 Pearl Street. | **BUFFALO: cor. Seneca and Wells Streets.**
PHILADELPHIA : J. W. Cregar Agency, "The Bourse."

You are cordially invited to visit our Exhibit at the PAN-AMERICAN EXHIBITION, Machinery Building, Section No. 38.

The Caskey Portable Pneumatic Punch.

FOR LIGHT AND HEAVY WORK.



BUILT IN FOUR SIZES. Cut shows Size I.

Saves exactly half the space in length needed to do the same work with a stationary power punch.

Saves more than half the labor, but one man being required, who can readily do more work than several men on stationary machine.

Saves expense of drilling on many lines of work that cannot be done on power punch.

Avoids much inaccurate work, being so much more easily guided and controlled in the hands of one man than a sheet or beam moved by several men at once.

Construction is extremely simple, insuring low cost of repairs.

Prices, references, and all further information, on application to the builders.

F. F. SLOCOMB & CO.

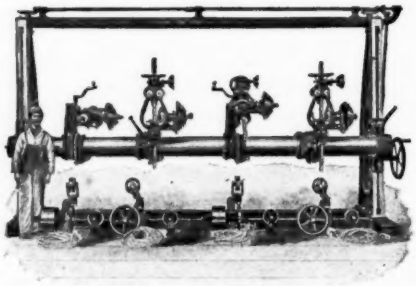
Wilmington, Del.

Drilling Machines and Engine Lathes

WE build the most extensive line of Drilling Machines of anyone in the world.

Our Engine Lathes are from 12 inch to 24 inch swing.

SEND FOR NEW CATALOGUE.



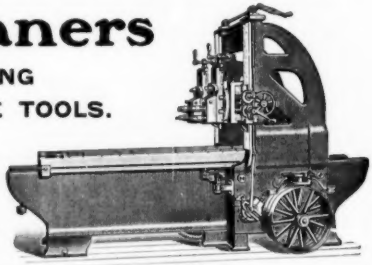
PRENTICE BROS. COMPANY, Worcester, Mass., U.S.A.

FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Vienna, Brussels, Stockholm, Cologne and St. Petersburg. Ad. Janssens, Paris. Charles Churchill & Co, London and Birmingham.

Whitcomb Planers

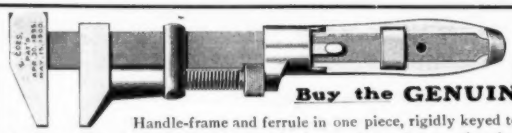
HOLD A HIGH PLACE AMONG STANDARD AMERICAN MACHINE TOOLS.

17 in. x 17 in. to 48 in. x 48 in.



Whitcomb Mfg. Co.,

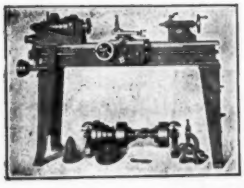
Worcester, Mass., U. S. A.



For Strength, Durability, Quality of Finish Buy the GENUINE COES WRENCH.

Handle-frame and ferrule in one piece, rigidly keyed to the bar, making practically one solid piece of metal; the ferrule and cup tip firmly securing and preventing the wood sides from splitting.

COES WRENCH COMPANY, - Worcester, Mass.



Lathes, Punches, Shears.

WE want to send you a Folder giving the Points of Excellence of this Lathe. . . . .

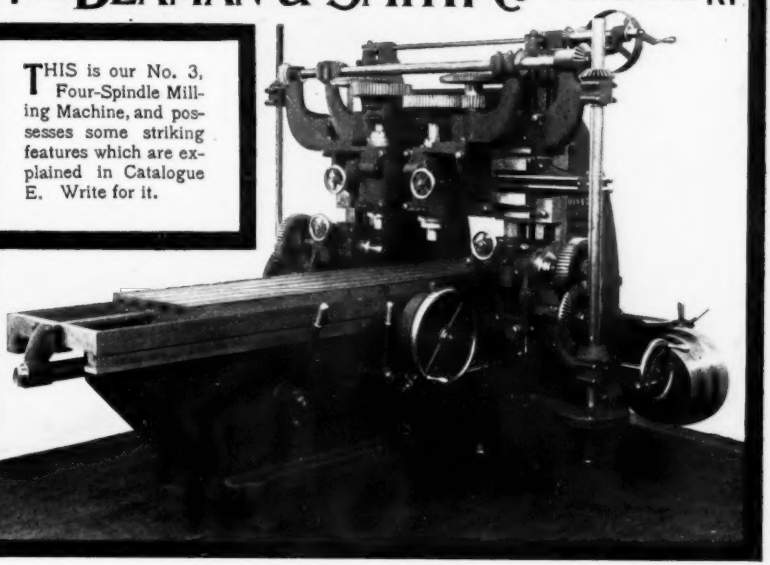
FREE ON APPLICATION.

W. C. YOUNG MFG. CO., WORCESTER, MASS., U. S. A.

Please mention The Engineering Magazine when you write.

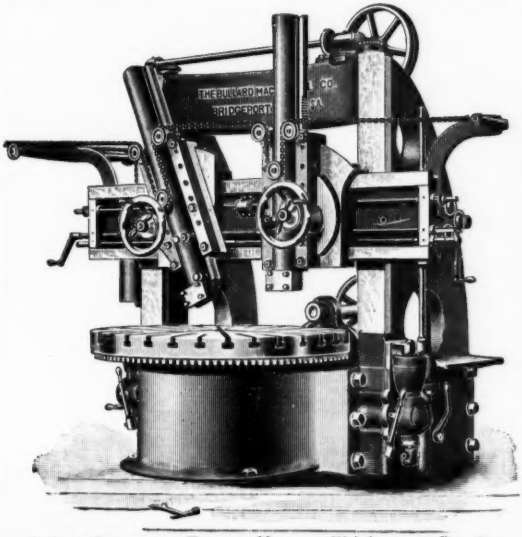
THE BEAMAN & SMITH CO · PROVIDENCE · RI ·

THIS is our No. 3, Four-Spindle Milling Machine, and possesses some striking features which are explained in Catalogue E. Write for it.



We make a Specialty of **BORING AND TURNING MILLS**

From 30 to 76 inch Capacity.



62-INCH BORING AND TURNING MILL. Weight, 20,700 Pounds.

The Bullard Machine Tool Co.

Bridgeport, Conn.,

U. S. A.

AGENTS:

Marshall & Huschart Machinery Co., Chicago, Cleveland, Cincinnati.

Ludw. Loewe & Co., Ltd., 30-32 Farringdon Road, London, England.

Ste. Ame des Establissements. A. Janssens, Paris, France.

Schuchardt & Shutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St. Petersburg.

Please mention The Engineering Magazine when you write.

Betts Machine Co.,

WILMINGTON, Del., U. S. A.

MAKERS OF

Heavy Machine Tools

OF THE

MOST ADVANCED TYPES.

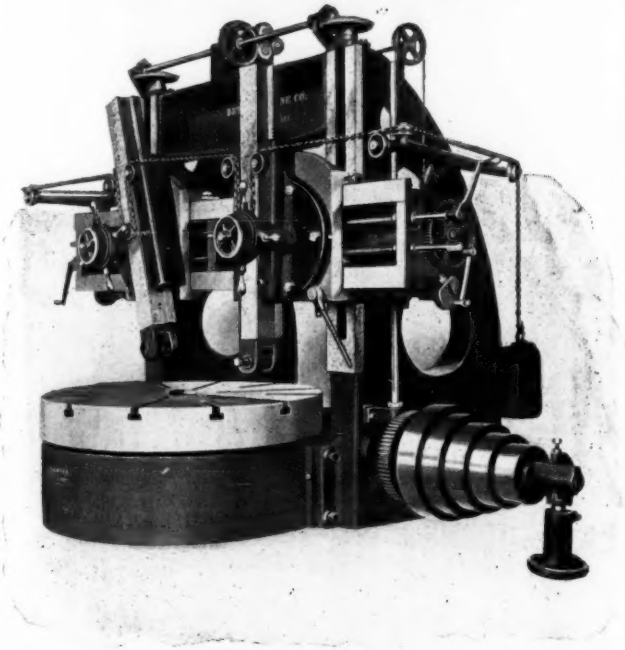
HORIZONTAL BORING MACHINES,
Usual Sizes.

VERTICAL BORING MILLS,
from 5 ft. to 20 ft. swing.

PLANING MACHINES,
from 3 ft. to 10 ft. square.

SLOTTING MACHINES,
from 8 in. to 24 in. stroke.

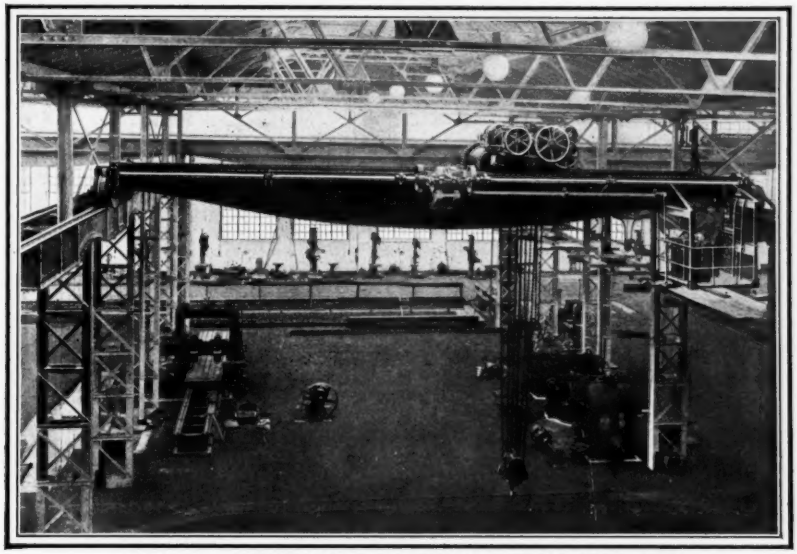
Cable—Betwildel, Wilmington.



The above illustration shows our Patented Worm Driven, 5 ft. Boring and Turning Mill. Swings, 65 in ; takes in work 44 in. under tool holders ; 49 in. under the cross-rail. Table, 57 in. diameter Tool bars, 30 in. travel.

Entirely Self-Contained, and *all Parts Stand Above the Floor.*

Niles Electric Traveling Cranes

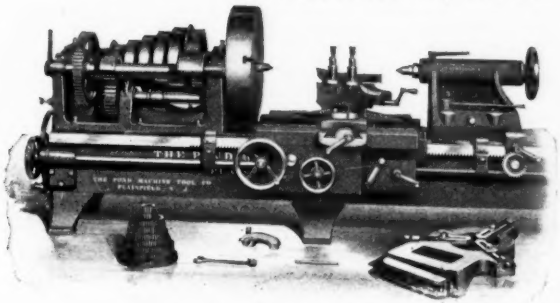


Address, THE NILES TOOL WORKS CO.,

CRANE SHOPS: Philadelphia, Pa. MAIN OFFICE: 136 138 Liberty Street, New York.

THE POND MACHINE TOOL CO.,

PLAINFIELD, N. J.



Makes a Specialty of Heavy Engine Lathes, 28 in., to 54 in. Swing.

32 IN. T. G. POND ENGINE LATHE.

Awarded Gold Medal at Paris Exposition.

OFFICES:

NEW YORK: 136-138 Liberty Street.
CHICAGO: Western Union Building.
PITTSBURG: Carnegie Building.
BOSTON: 65 Oliver Street.
PHILADELPHIA: 21st and Callowhill Streets.
BUFFALO: Seneca and Wells Streets.
ST. LOUIS: 615 N. 4th Street.
LONDON: 23-25 Victoria Street, S. W.

Please mention The Engineering Magazine when you write.

CLEVELAND

Punches, Plate Planers, Metal Saws,
Shears, Rotary Planers, Bending Machines,
Rolls, Radial Drills, Riveters

Are in use the World over.

Specify **CLEVELAND** Tools if you want the Best.

THE CLEVELAND PUNCH & SHEAR WORKS CO.,
Cleveland, U. S. A.

MODERN MACHINE TOOLS

..FOR..

SHIP YARDS, PLATE MILLS, BRIDGE WORKS, BOILER SHOPS.

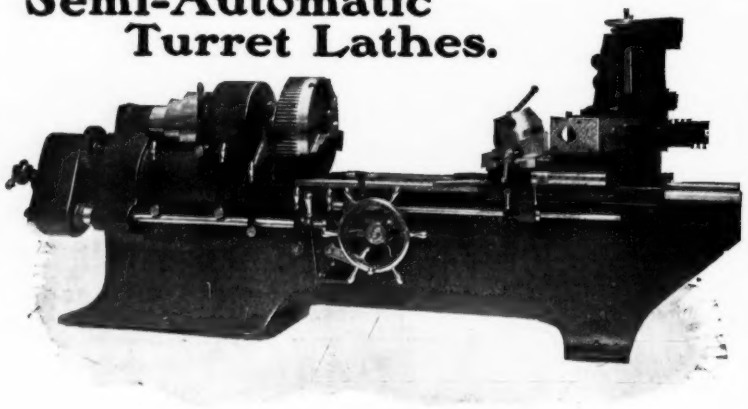
HILLES & JONES COMPANY,
WILMINGTON, DELAWARE.

Punches, Shears, Plate Planers.

Plate Straighteners For Mills.

Bending Rolls, Straighteners, Beam Copers.

Semi-Automatic Turret Lathes.



THE LATEST TURRET LATHE.

12 Changes of Speed, without Stopping.
8 Changes of Feed.
6 Rates of Back Gear, maximum ratio 83-1.
New Type Turret, with Universal Tool Holders, Power-handled throughout.

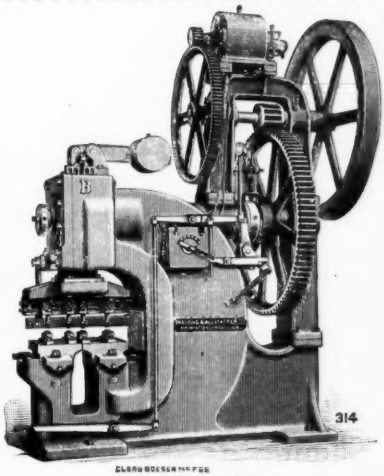
American Turret Lathe Co., - Wilmington, Del., U. S. A.

Marshall & Huschart Machinery Co., *Chicago, Cleveland and Cincinnati.*

133 LIBERTY STREET, NEW YORK.

Markt & Co., *London, Paris, Hamburg, Manchester.*

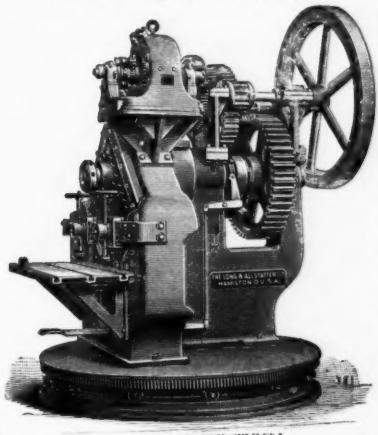
Please mention The Engineering Magazine when you write.



Save Time and Money

On STRUCTURAL IRON and BRIDGE WORK

by using the Latest and Most Improved Tools for Punching, Coping and Cutting off Beams, Channels, Angles, Z Bars, etc., etc.



Manufactured by

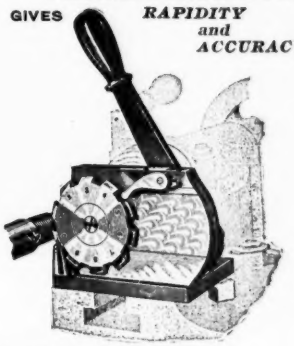
THE LONG AND ALLSTATTER CO.,

HAMILTON, OHIO.

Correspondence Solicited. **Estimates Furnished.**

NEW DEPARTURE LABOR SAVING THREAD CUTTING TOOL.

GIVES *RAPIDITY and ACCURACY.*



GUARANTEES Absolute Duplication.
Renders Manual Skill Unnecessary.
Will Pay for Itself in Labor Saving in Three Weeks.
No Machinist Running a Screw Cutting Lathe Can Afford to do Without it.
The Use of This Tool Produces the Highest Degree of Perfection.

When writing for Catalog Ask for Series D.

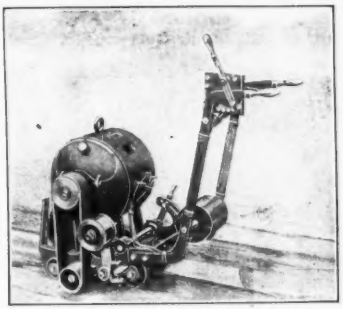
The Rivett-Dock Co.,

Brighton, Boston, Mass, - U. S. A

WE CAN SAVE YOU TIME

Pneumatic, Electric and Rope-Driven

PORTABLE DRILLS, BOILER SHELL DRILLS, CHIPPING TOOLS, DECK PLANERS, ETC.

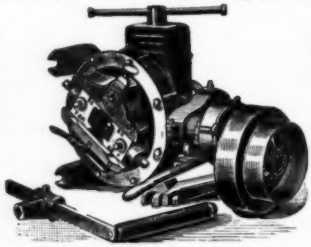


Portable Electric Wood or Deck Planer.

Ask for Descriptive Circulars.

THOS. H. DALLETT & CO.,

23d and York Streets, PHILADELPHIA, PA., U. S. A.

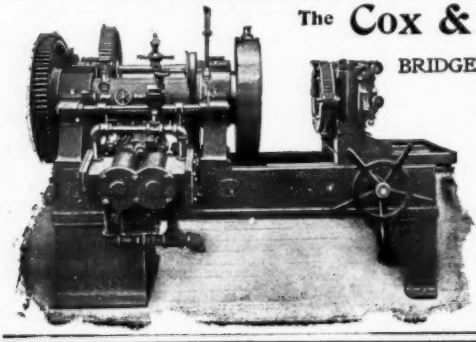


No. 0 Machine with Power Attachment.
—Get Catalogue 139.—

A TIME SAVING
THREADING MACHINE,
EITHER HAND OR POWER,

Designed for threading pipe from ⅛ inch to 2 inches inclusive. Hand machine can be taken out on a job, along with other tools, and attached to a beach or post. Full line of adjustable stocks, dies and other tools.

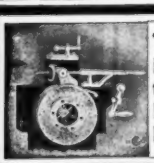
THE ARMSTRONG MFG. CO.,
139 Centre St., N. Y. BRIDGEPORT, CONN.



The **Cox & Sons Company,**
BRIDGETON, N. J.
BUILDERS OF
PIPE CUTTING AND THREADING MACHINERY
Of Thirty Different Styles and Sizes.

Cut represents our six-inch engine driven machine, which has become popular for shop work, the installing of large steam plants and for use in mines. Attach to it a steam pipe and it is ready for use.

New Catalogue Now Ready.
Philadelphia Office, 215 Race St.



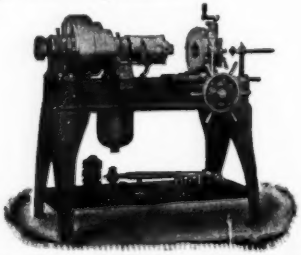
This is the Die Head.

Our **Pipe Threading Machines** have other features as good as this one. Let us tell you about them. Machines for hand or power—¼ inch to 18 inches.
Bignall & Keeler Mfg. Co., Edwardsville, Ill., U. S. A.

These are the Tools for it.

The Apex No. 1.

This is a new type of Machine, with many desirable improvements.
Write for free descriptive catalogue of Pipe Threading Machines.



THE MERRELL MFG. CO.,
10 Curtis St., TOLEDO, Ohio, U. S. A.
European Office: THE FAIRBANKS CO., 16 Great Eastern Street, LONDON, E. C.

PAINT

For MACHINE TOOLS and OTHER MACHINERY.
Rice's XXth Century Finish.

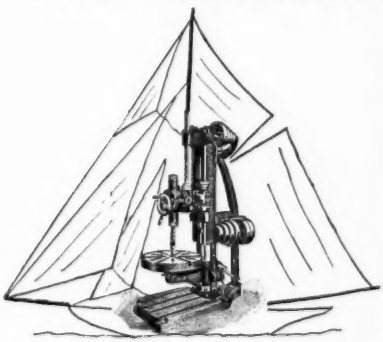
Send for booklet, "How to Get the Finest Finish at the Least Cost."

U. S. Gutta Percha Paint Company,
PROVIDENCE, - - - - R. I.

R. POOLE & SON CO.
ENGINEERS, FOUNDERS and MACHINISTS,
BALTIMORE, MD.
MANUFACTURERS AND DESIGNERS OF ALL KINDS OF
HEAVY MACHINERY,
REQUIRING FIRST CLASS WORKMANSHIP AND MATERIALS.
BAND, ROPE and FLY WHEELS, FRICTION CLUTCHES, SHAFTING, PULLEYS and HANGERS.
MACHINE MOLDED AND PLANED GEARING.
MACHINERY for WHITE LEAD and FERTILIZER WORKS, GRAIN ELEVATORS and FLOUR MILLS, BRASS, COPPER and TIN PLATE ROLLING MILLS, CABLE and MARINE RAILWAYS.
POOLE-LEFFEL TURBINE WATER WHEELS.
DREDGING MACHINES.
CIRCULARS ON APPLICATION.
IRON CASTINGS of 30,000 LBS. TENSILE STRENGTH.

J. G. SPEIDEL,
Manufacturer of READING, PA.
Improved Chain Hoist,
Overhead Tramway,
Handpower Travelling Cranes,
Elevators and Dumbwaiters.
Catalog Mailed free.

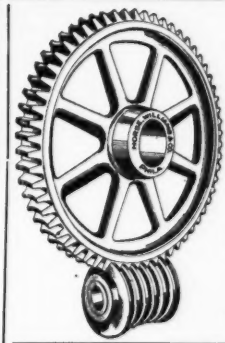
Two winners.



We are sure winners in the race for Economy on a great deal of work usually done on a turret lathe.

Notice the multiple driving head and write for descriptive circular.

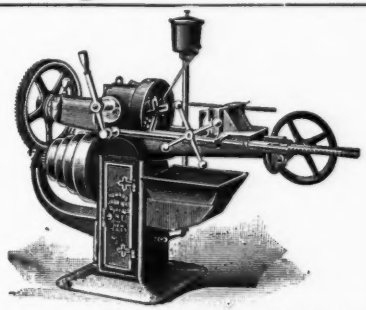
A. D. QUINT,
2 Clinton St., HARTFORD, CONN.



Hindley Worm Gearing.

Morse, Williams & Co.,
PHILADELPHIA.

Write for Catalogue P.

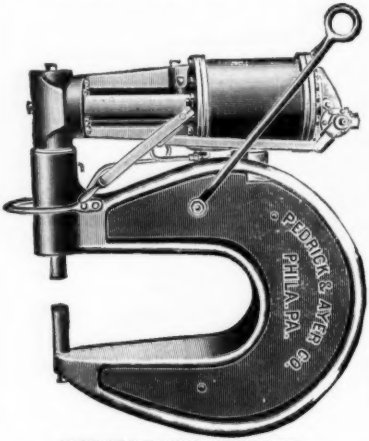


Double-Headed 4-Die Bolt Cutter.

Send for Catalogue of Complete Line.
HOWARD IRON WORKS,
BUFFALO, N. Y.

Please mention The Engineering Magazine when you write.

PEDRICK & AYER CO., PHILADELPHIA, PA.



PORTABLE PNEUMATIC RIVETER.

Compressed Air RIVETERS...

HOISTS, CRANES, AIR COMPRESSORS, AND OTHER TOOLS FOR SHOP, YARD, AND FOUNDRY USES

Our new line of Portable Riveters comprises several styles and sizes, and are adapted for any kind of work. These Riveters secure the maximum pressure on the Rivet, with as little weight in the machine as is possible. They work rapidly, without jar or shock, and give a uniform pressure upon every rivet. SPECIAL STYLES BUILT TO ORDER.

....Write for Catalogue.

SOLE SALES AGENTS:

MANNING, MAXWELL & MOORE, 85-87-89 Liberty St., New York, U. S. A.

CHICAGO OFFICE: 22-24-26 South Canal Street.
PITTSBURG OFFICE: Park Building.
CLEVELAND OFFICE: 26 South Water Street.
BOSTON OFFICE: 128-130 Oliver Street.

Send for Catalogs of . . .

Multiple Spindle Drills,

Vertical and Horizontal. 4 to 24 Spindles.

Radial Drills.

Boring and Turning Mills.

Baush Machine Tool Co.

SPRINGFIELD, MASS., U. S. A.

MECHANICAL MOVEMENTS

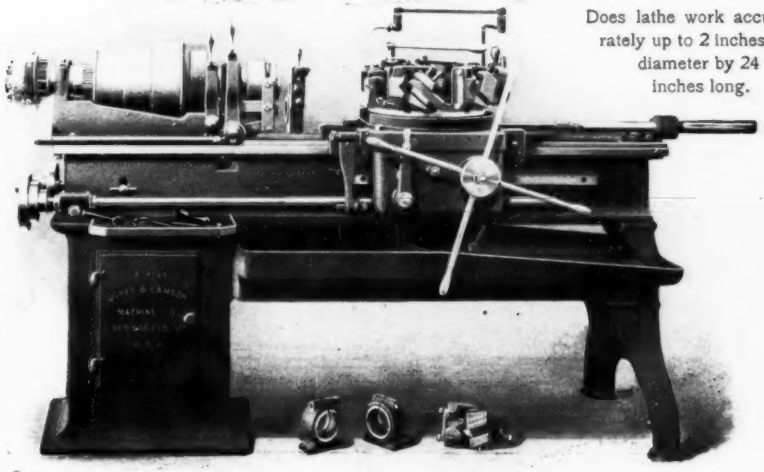
By GARDINER D. HISCOX, M. E.

A Dictionary of Mechanical Movements, Powers, Devices and Appliances, embracing an illustrated description of the greatest variety of mechanical movements and devices, in any language. A new work on illustrated mechanics, mechanical movements, devices and appliances, covering nearly the whole range of the practical and inventive field, for the use of Machinists, Mechanics Inventors, Engineers, Draughtsmen, Students, and all others interested in any way in the devising and operation of mechanical works of any kind.
Large 8vo; 1,640 illustrations; 400 pages.

Price, Cloth, $3.00.

THE ENGINEERING MAGAZINE, 120-122 Liberty St., New York.

THE FLAT TURRET LATHE.

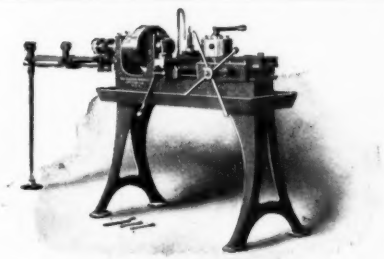


Does lathe work accurately up to 2 inches diameter by 24 inches long.

Jones & Lamson Machine Company, Main Office and Works: **SPRINGFIELD, Vermont, U. S. A.**

A, B, C, and Lieber's Codes used.

English Office: Room 6, Exchange Building, Stephenson's Place, Birmingham.
France and Spain: Ph. Bonvillain, 6, Rue Blanche, 6, Paris, France.
Germany, Belgium, Holland, Switzerland and Austria-Hungary: M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany.



SCREW MACHINES AND TURRET LATHES.

Well designed and accurately built machines at a reasonable price. New features include New Wire Feed, New Chuck which reduces the Overhang, New Power Feed for turret slide, New Friction Clutch on the back geared machines, and **The Best Countershaft ever built.**

Send for Catalogue and Testimonials.

THE PEARSON MACHINE CO.,

45 W. Randolph St., CHICAGO, ILL.

Cable Address, Pearson Chicago. Lieber's Code.

Consult the Engineering Index in this number.

YOUR ELECTRIC MOTOR

will run without noise if connected to your machines with

NEW PROCESS PINIONS

They have many advantages over metal. Write for catalogue.

THE NEW PROCESS RAW HIDE CO.
SYRACUSE, N.Y.

Please mention The Engineering Magazine when you write.

CARBORUNDUM

Long-lived grinding wheels are money-saving wheels.
A Carborundum Wheel will do two to four times the work of any other abrasive wheel, before becoming useless.
And at the same time it will do its work faster and better.
Carborundum is guaranteed to save money to its users.

Write for the booklet.

The Carborundum Co.
Niagara Falls, N. Y.

EMERY WHEELS.

GRINDING MACHINERY.

AGENCIES:
"ALL OVER THE WORLD."

Norton Emery Wheel Co.,
WORCESTER, MASS.

Chicago Store—25 So. Canal St.

Automobilism.

Leading articles from leading engineering journals record progress in Motor Vehicles. See the Engineering Index in this magazine. . . . . .

$65.00 BUYS THE BEST Water Emery Tool Grinder.

ON THE MARKET.

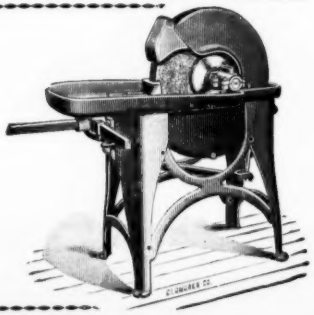
SIMPLE. PRACTICAL. EFFICIENT.

No pump to cut out; no float to rust out; no time consuming adjustments to make. It's all that a Tool Grinder should be, and the price is right.

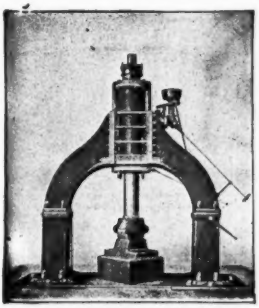
Complete with countershaft and 24 in. x 2 in. wheel and trueing device, $65.00 F. O B. cars Rockford.

Better ask us to send you printed matter.

B. F. BARNES COMPANY,
ROCKFORD, ILL.



Please mention The Engineering Magazine when you write.



2¼ TON STEAM HAMMER.

William Sellers & Co. Incorp.

PHILADELPHIA, PA.

STEAM HAMMERS.

Note.—We show herewith a 2¼ ton Hand-Acting Steam Hammer with Bed and Anvil Block in position.
Takes Steam above and below Piston.
Has balanced Piston Valves and Patent Exhaust arrangement.

No 3 UNIVERSAL GRINDER.
12 in. Swing, 42 in. between Centers.

Grinding... Machines,

PLAIN AND UNIVERSAL.

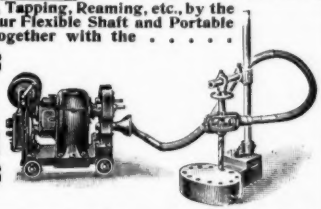
Eight Sizes manufactured by

LANDIS TOOL CO.,

Waynesboro, Pa.

WE GUARANTEE easier and quicker work done in Drilling, Tapping, Reaming, etc., by the use of our Flexible Shaft and Portable Tools, together with the . . . . .

Electric Motor of the General Electric Co.,



than by any other method. See our Catalogue No. 2.

STOW FLEXIBLE SHAFT CO.

26th and Callowhill Streets, Philadelphia.
Frederic Schoff, Prop.

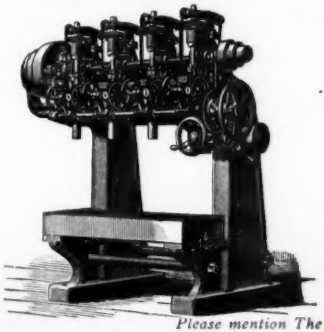
BARNES' UPRIGHT DRILLS.

Complete line, ranging from our New Friction Disk Drill, for light work to 42-inch Back Geared, Self Feed Drill.

Send for Catalogue and Prices.

W. F. & JOHN BARNES CO.,

953 Ruby Street, Rockford, Ill



IT'S VOLUME OF WORK

that brings profits. One of our multiple drills will help materially to increase your output.
Send for our "Red Book" for description of our entire line.

The Bickford Drill & Tool Co.,

Cincinnati, Ohio, U. S. A.

PAUL S. REEVES & SON,
PHILADELPHIA, PA.
MANGANESE BRONZE,
PHOSPHOR BRONZE
AND BABBITT METALS.
Brass and Phosphor Bronze Castings from 1-4 lb. to 10,000 lbs. in Weight.

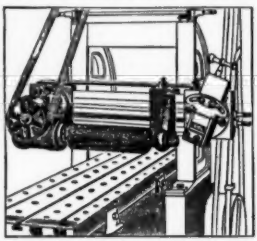
FLANGES, Soft Steel.....
Weldless Flanges,
FORGED AND ROLLED FROM **SOLID STEEL INGOTS,**
SUITABLE FOR HIGH PRESSURE STEAM, WATER OR GAS LINES.
FOR DETAILS AS TO PRICES, ETC., ADDRESS
LATROBE STEEL CO., 1200 Girard Building, Philadelphia.

JESSOP'S STEEL FOR TOOLS, DRILLS, SAWS, &c
ALL KINDS IN STOCK. DIES.
MANUFACTORY, SHEFFIELD, ENGLAND.
GOLD MEDAL PARIS 1889
HIGHEST AWARD CHICAGO
CHIEF AMERICAN OFFICE, 91 JOHN ST. NEW YORK.
WILLIAM JESSOP & SONS, L'D. W. F. WAGNER, GEN. M'GR.

MALLEABLE NICKEL,
SHOT, PLATES, INGOTS,
BARS SHEETS, WIRE.
Best Quality for Anodes, German Silver and Nickel-Steel.
ORFORD COPPER CO.,
COPPER BUILDING:
Cor. JOHN AND CLIFF STS., NEW YORK.

STEEL CASTINGS
of every description, weighing from 10 lbs. to 10 tons. Send specifications for prices.
THE LIMA STEEL CASTING CO.,
LIMA, OHIO, U. S. A.

WILSON IMPROVED IRON PLANERS
STANDARD SIZES KEPT IN STOCK.
W. A. WILSON,
215 WATER STREET, ROCHESTER, N. Y.

MILLING MACHINE

combined with any
Iron Planer
Swivels from Horizontal to Vertical.
Do not plane surfaces that should be milled or mill surfaces that should be planed.
SEND FOR CATALOG.
The Adams Company, Dubuque, Ia.

Tools for Sheet Metals
Presses and Punches,
Squaring and Rotary Shears,
Tinsmiths' Tools, &c.
MADE BY
Niagara Machine & Tool Works,
BUFFALO, N. Y.

REG. TRADE MARKS

THE PHOSPHOR BRONZE SMELTING CO. LIMITED.
2200 WASHINGTON AVE., PHILADELPHIA.
"ELEPHANT BRAND PHOSPHOR-BRONZE"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, ETC.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U.S.

POINTS
-IN-
LOCKERS.

THIS LOCKER has more desirable points than any other for shop use. They have been developed by experience. We cannot enumerate them in this space.

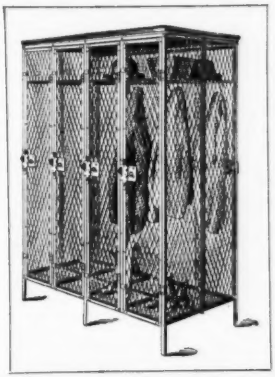
Send for Booklet on Lockers and Wardrobes.

Narragansett Machine Co.,
Providence, R. I.

WE ASK YOU TO CONSIDER
THE PRACTICAL ADVANTAGES OF THE
EXPANDED METAL LOCKER.

SANITARY,
SECURE,
DURABLE,
ATTRACTIVE,
REASONABLE.

IN ANY SIZE
OR
ARRANGEMENT.



ADOPTED BY
U. S. NAVY DEPT.
U. S. TREASURY DEPT.
NEW YORK, NEW HAVEN & HARTFORD R. R.
PENNA. R. R.
GEN'L ELECTRIC CO.
WESTINGHOUSE ELECTRIC & MFG. CO.
NIAGARA FALLS POWER CO.
OTHERS.

MERRITT & COMPANY,
1020 Ridge Avenue, PHILADELPHIA.

Please mention The Engineering Magazine when you write.

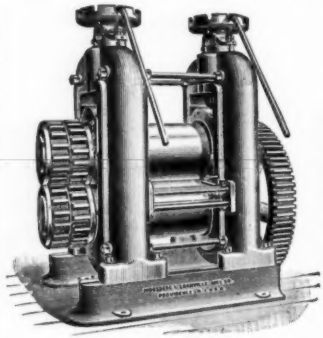
MOSSBERG & GRANVILLE MFG. CO.,

150 NASSAU STREET, NEW YORK,

MANUFACTURERS OF

ROLLING MILLS,

FITTED WITH ROLLER BEARINGS.



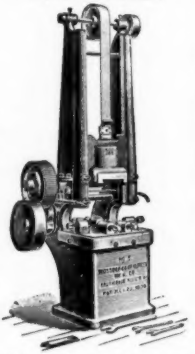
SHEET MILL, 2: x 30 RoLLS.

SHEET MILLS.
ROD MILLS.
REVERSING MILLS.
MERCHANT BAR MILLS.
BRASS MILLS.
CROSS ROLLING MILLS.
WIRE FLATTENING MILLS

DROP PRESSES.

Plain and Automatic. 10 Sizes of the Plain Drops; 12 Sizes of the Automatic Drops,

GRADING MILLS.



No. 5. Automatic Drop Press.

POWER PRESSES. WIRE DRAWING MACHINERY.

Information on above machinery gladly given. Send for Catalogue.

EXHIBITION AT PHILADELPHIA BOURSE.

FOREIGN AGENTS: CHARLES CHURCHILL & CO., LTD., London and Birmingham, England. A. MATHEY DORET, Lachaux-de-Fonds, Switzerland. DE FRIES & CO., Dusseldorf and Berlin, Vienna, Austria. ADOLPHE JANSSEN, Paris.

CONTINUOUS MILLS

For BILLETS, MERCHANT BAR, RODS, HOOPS & COTTON TIE.

WIRE-DRAWING MACHINERY--FOR STEEL, COPPER OR BRASS.

MORGAN CONSTRUCTION COMPANY, Worcester, Mass., U.S.A.

The WHITING Cupola 800 in Use COMPLETE FOUNDRY PLANTS

Cranes

Electric Travelers

WHITING FOUNDRY EQUIPMENT CO.

HARVEY, ILL., U. S. A. (Chicago Suburb).

Catalogue (E) free on request.

CRANES, AIR HOISTS All types 15 Sizes. ENGINEERS AND DESIGNERS.

DROP FORGINGS

FROM MODEL OR DRAWING.

STRIEBY & FOOTE CO.,

301 Ogden Street, NEWARK, N. J.

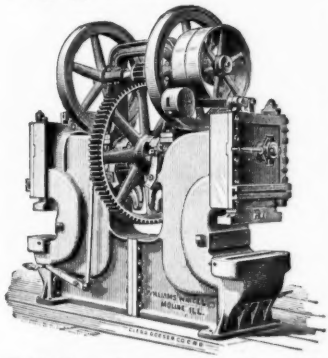
Bulldozers all sizes, for all purposes; double geared or single geared; fast, medium or slow speed; die space and stroke to suit your requirements. WITH FRICTION CLUTCH. HARD STEEL SLIDING SURFACES FOR CROSSHEAD. SEE OUR NO. 9.

Drop Hammers both of the **Board-Lifting** and the **Crank-Rope Lift Type.**

COAL CHUTES FOR COALING LOCOMOTIVES

Justice Hammers. Very speedy, long stroke, hard hitters, and under particularly good control. Adapted to a great variety of work.

Forging Presses.



Yeakley Vacuum Hammers. The most efficient forging and welding tools in the world to-day; fifty per cent. more work done than with other hammers.

Eye Bending and Welding Machines. Noiseless, adjustable stroke, friction drive.

Gang Boring Machines. To bore six to ten holes in wood simultaneously

Punching and Shearing Machines For all purposes—boiler, bridge, structural, railroad, car, agricultural implement work, etc.

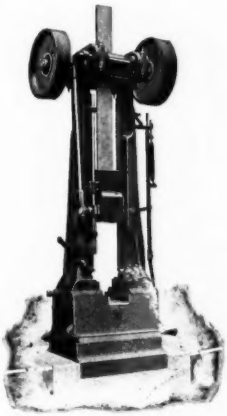
Multiple PUNCHES and Gate SHEARS.

Billet Shears.

Roll Tapering or Forging Machines. **Tire Welders and Benders.**

Spoke Riveters, Axle Lathes, Skein Presses Etc., Etc.

WILLIAMS, WHITE & CO., MOLINE, ILLINOIS, U. S. A



MERRILL BROS.,
475 Kent Avenue,
BROOKLYN, N. Y.

Send for circular.

WANTED.

Man with good executive ability who has had practical experience and preferably a technical education to take charge of foundry and machine departments for large manufacturing concern. Good salary. Answer treated confidentially.

Address FOUNDRIES, Care of THE ENGINEERING MAGAZINE, 120-122 Liberty St., New York.

Steam Dock Crane.

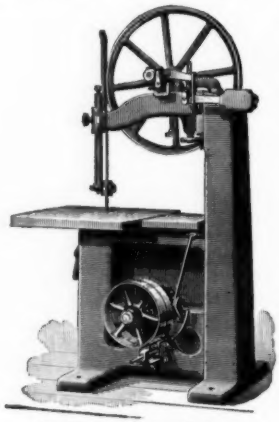
HIGH GRADE, TRAVELING, JIB, PILLAR AND LOCOMOTIVE **CRANES**

Northern Engineering Works,

NO. 645 ATWATER STREET, - DETROIT, MICH., U. S. A.

Please mention The Engineering Magazine when you write.

"Grand Prix," Paris, 1900.



No. 50. Band Scroll Saw.

J. A. Fay & Egan Co.,

212-232 W. Front Street, Cincinnati, Ohio.

WOOD WORKING MACHINERY.

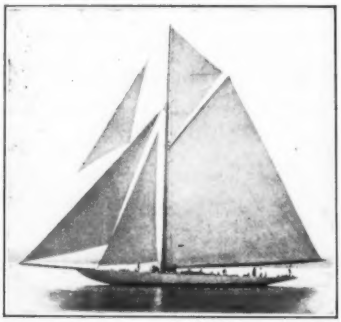
WOOD WORKING MACHINERY of SUPERIOR QUALITY embodying all improvements. An exclusive experience in this line of 54 years. AND THIRTY DAYS' TRIAL BEFORE PURCHASE are our guarantees of your satisfaction.

CATALOGUES AND LARGE PHOTOGRAPHS OF ANY MACHINE (10X14) SENT UPON APPLICATION

H.B. SMITH MACHINE CO.
SMITHVILLE, N.J. U.S.A.

Upon application we will send THE MECHANIC, a journal of practical interest to Machine Wood Workers, to any owner, superintendent or foreman of a machine wood working establishment for one year, free of cost.
LOCK BOX 10 – SMITHVILLE, N.J.

YACHT "CONSTITUTION."



Our Process did this:

Galvanized the deck and other parts of the Constitution, saving 1,200 lbs. in weight.

You can Save All the Spelter

consumed in galvanizing by the hot process by using our Patent Cold Galvanizing Process, as the amount of spelter lost as dross in the hot process gives sufficient protection to any kind of work to make it rust-proof even against salt air and sea water, which fact has been established by many tests. Our Patent Process is now in use all over the country. Our licensees include *U. S. Government, The Standard Oil Co., The Herreshoff Boat Building Co., etc.*

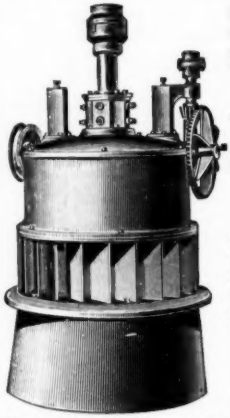
Licenses granted on Royalty Basis.

Sample and Custom Work done at our factory, 108-110 West 11th Street.

U. S. ELECTRO-GALVANIZING CO.

348 Broadway, New York.

THE VICTOR TURBINE.



is adapted for driving . . . .

Power Plants

of all kinds.

Compactness, Simplicity, Strength

and accessibility of all parts are pre-eminent features in the construction of this TURBINE.

ILLUSTRATED CATALOGUE ON APPLICATION.

The Stillwell-Bierce & Smith-Vaile Co.

260 LEHMAN STREET, DAYTON, OHIO, U. S. A.

FREDERICK NELL, Sales Agent, 97, Queen Victoria St. LONDON, E. C.

Crocker-Wheeler Company,

MANUFACTURERS AND ELECTRICAL ENGINEERS.

General Offices and Works:
AMPERE, N. J.,
U. S. A.

Engine Type Generators and Boosters for Railway, Power and Lighting Work. Direct Connected Marine Sets.

DIRECT CURRENT MACHINERY for all PURPOSES.

Belt Type Motors and Dynamos. Fully and Semi-enclosed Motors. Mill, Elevator and Hoist Motors.

BRANCH OFFICES:

NEW YORK, 39 Cortlandt Street.
BOSTON, 31 State Street.
PHILADELPHIA, 1410 North American Bldg.
ST. LOUIS, 642 Century Building.
CHICAGO, 1390 Old Colony Building.
DENVER, 1732 Champa Street.
WASHINGTON, 1417 New York Avenue.
PITTSBURGH, 607 Empire Building.
SAN FRANCISCO, Abner Doble & Co.

The Depreciation of Factories

MINES AND INDUSTRIAL UNDERTAKINGS AND THEIR VALUATION.

BY EWING MATHESON.

GENERAL CONTENTS.

DEPRECIATION

General Practice, Division into Classes, Of Land and Buildings, Plant, Machinery, Diminished Value, Examples, Tables.

VALUATION

Different Kinds, Of a Factory as a Going Concern, Rental Value, Of a Factory Shut Down, Losses by Fire, Rentable Value of Factories, Trade Fixtures, Bills of Sale, Debentures, Location.

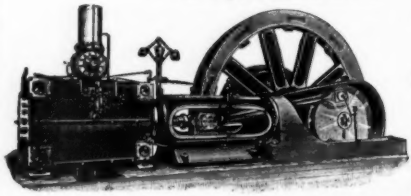
GENERAL INDEX.

143 Pages; Side Notations; Two Diagrams.
8vo., Cloth; Price, $3.00; sent prepaid, by

The Engineering Magazine Press,
120-122 LIBERTY STREET, NEW YORK, U. S. A.

HAMILTON-CORLISS

Correspondence Solicted. Call for Catalogue B.



Highest Efficiency and Superior Construction.

Non-Condensing. Condensing. Compound. Triple-Expansion or Quadruple Expansion.

Close Regulation and best Attainable Economy of Fuel and Steam.

THE HOOVEN, OWENS RENTSCHLER COMPANY, HAMILTON, OHIO, U. S. A.

SOUTHWARK FOUNDRY & MACHINE CO.,

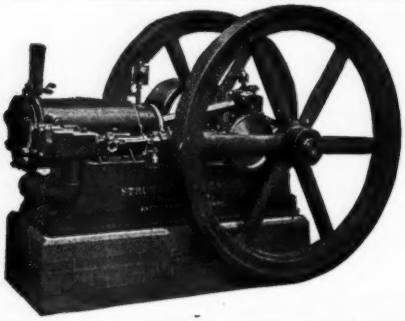
Philadelphia, Pa.

PORTER-ALLEN AUTOMATIC ENGINES.

BLOWING ENGINES. CENTRIFUGAL PUMPS.

WEISS COUNTER-CURRENT CONDENSERS.

INQUIRIES SOLICITED.



The Warren Gas and ..Gasoline Engine.

All Sizes.
Remarkable Simplicity.
Greatest Economy.

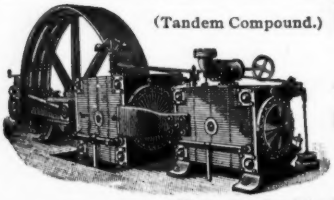
Struthers, Wells & Co.,
WARREN, PA.
N. Y. OFFICE, 26 CORTLANDT ST.
Philadelphia Office, Fidelity Mutual Building.

CHANDLER & TAYLOR COMPANY, INDIANAPOLIS, INDIANA, U. S. A.

MANUFACTURERS OF

Single Cylinder and Tandem Compound Automatic Cut-Off Engines, Plain Slide Valve Engines, Double Engines, Horizontal Tubular Boilers, Firebox Boilers, Upright Boilers, Saw Mills and Saw Mill Machinery.

COMPLETE POWER PLANTS. Write for Catalogues and Information.



(Tandem Compound.)

Frick Company, Waynesboro, Pa., U. S. A.

ECLIPSE CORLISS ENGINES.

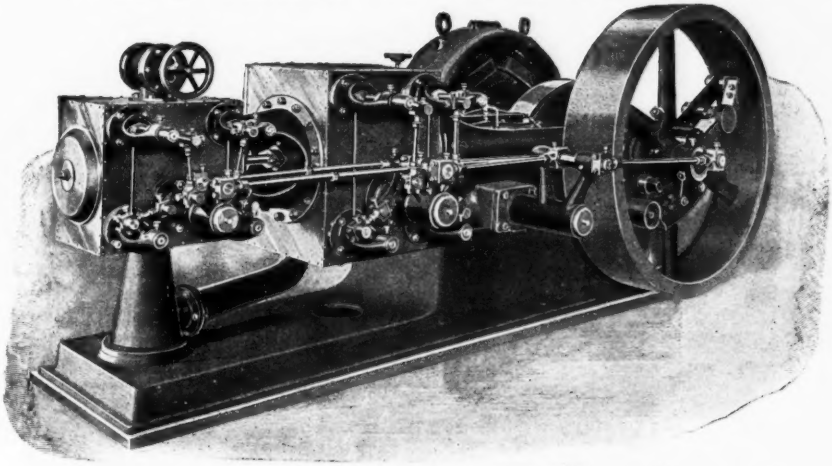
40 to 2000 H. P. All styles. Send for Illustrated Catalogue.

ALSO BUILDERS OF

ELECTRIC HIGH-SPEED ENGINES and ICE MAKING and REFRIGERATING MACHINERY.

NEW YORK OFFICE:
Taylor Building, 39-41 Cortlandt Street.

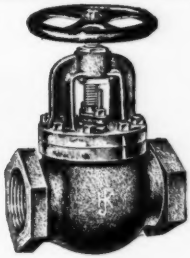
The Ball & Wood Co.



Automatic Cut-off Engines.

Simple and Compound. Horizontal and Vertical.

Send for Descriptive Catalogue. *OFFICE, 120 LIBERTY ST., NEW YORK.*



THE KELLY & JONES COMPANY,

MANUFACTURERS OF

Iron Pipe Fittings, Brass & Iron Valves,

COCKS, ETC.,

For Steam, Gas, Water and Oil.

IRON AND STEEL TUBING.

New York. Chicago. Pittsburg. Works at GREENSBURG, PA.

THE

Alaska Valve Handle

Is the only Steam Valve Wheel that will not burn your hand.

TROY NICKEL WORKS,
ALBANY, N. Y.

Sizes below in stock. All handsomely finished.

Size Valve.	Outside Diam. of Wheel.	Price Each.
¾-in	1½-in.	12c.
"	2 "	12c.
"	2½ "	14c.
1 "	3 "	16c.
1¼ "	3½ "	20c.
1½ "	3½ "	30c.
2 "	4 "	40c.
2½ "	4½ "	45c.

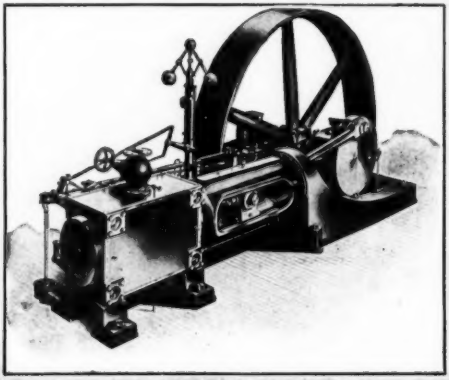
Less Trade Discount

Please mention The Engineering Magazine when you write.

ALLIS-CHALMERS CO.

... SUCCESSORS TO....

THE EDWARD P. ALLIS CO., Milwaukee. GATES IRON WORKS, Chicago.
FRASER & CHALMERS, Chicago. DICKSON MFG. CO., Scranton.



Reynolds .... Corliss Engines

FOR ALL POWER PURPOSES.

Pumping, Blowing and Hoisting Engines

Riedler Pumps and Compressors.

Special Engines for Electric Lighting, Street Railways and Rolling Mills

BRANCH OFFICES:
NEW YORK. DENVER. SPOKANE.
PITTSBURG. CITY OF MEXICO.
MINNEAPOLIS. LONDON.

GENERAL OFFICES:
CHICAGO, ILL.
HOME INSURANCE BLDG.

MEDIUM AND HIGH SPEED...

ENGINES.

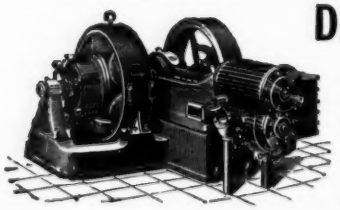
HIGHEST EFFICIENCY, BEST CONSTRUCTION.

Gold Medal, Paris, 1900.

THE BALL ENGINE CO.,

CHICAGO OFFICE: 1526 Monadnock Building. ERIE, PENNSYLVANIA.

American-Ball Duplex Compound Engine AND Direct-Connected Generator.



A Coal-Saver of the most practical kind and the most remarkable of recent engines.

Don't fail to investigate if you are interested.

We furnish complete equipments, consisting of engines, generators and motors of our own manufacture.

AMERICAN ENGINE COMPANY,

NEW YORK OFFICE, 95 Liberty St. 20 Raritan Avenue, BOUND BROOK, N. J.

Please mention The Engineering Magazine when you write.

TO many engineers "fracture in detail" and "the recalescent point" of steel are meaningless terms, and yet they bear an important relation to the life of shafts and general engine-forgings.

SEND TO OUR NEAREST OFFICE FOR PAMPHLET.

BETHLEHEM STEEL COMPANY,

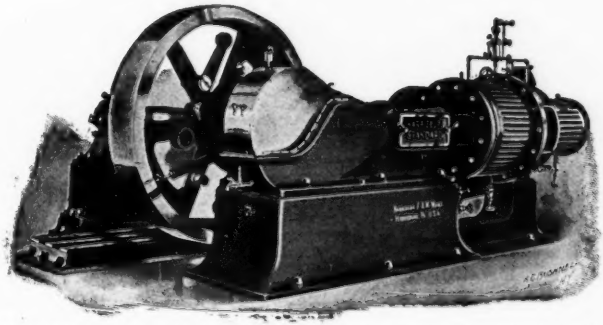
SOUTH BETHLEHEM, PA.

BRANCH OFFICES:

100 Broadway, New York.
421 Chestnut Street, Philadelphia.
1521 Marquette Building, Chicago.
430 Endicott Building, St. Paul.
Fremont and Howard Streets, San Francisco.
510 Security Building, St. Louis.
312 Perry-Payne Building, Cleveland.

(25)

Harrisburg Engines

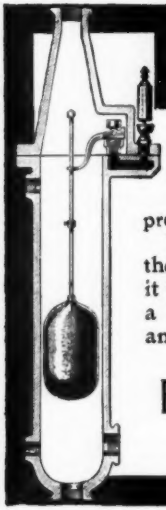


HARRISBURG STANDARD COMPOUND ENGINE—DIRECT CONNECTED STYLE

6 TO 3,000 HORSE-POWER
HIGH SPEED, MEDIUM SPEED AND CORLISS

Harrisburg Foundry and Machine Works
HARRISBURG, PA., U. S. A.

Please mention The Engineering Magazine when you write.



PITTSBURGH SAFETY WATER COLUMN

Muzzles the steam boiler so completely that it cannot get on a rampage and endanger life and property as it tends to do occasionally. The "Pittsburgh" not only causes the boiler to behave itself, but causes it to do more and better work. Put a Pittsburgh muzzle on your boiler, and it has to attend to its business.

Pittsburgh Gage & Supply Co.,

322 Water St., Pittsburgh, Pa.

THE MASON Reducing Valves

ARE THE WORLD'S STANDARD VALVES.

For automatically reducing and absolutely maintaining an even steam or air pressure.

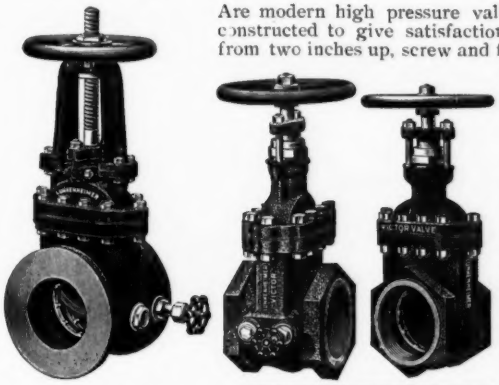
They are adapted for every need and guaranteed to work perfectly in every instance.

WRITE FOR FULL INFORMATION AND SPLENDID REFERENCES.

THE MASON REGULATOR CO. **Boston, *Mass., U.S.A.***

Please mention The Engineering Magazine when you write.

THE LUNKENHEIMER "VICTOR" Gate Valves



Are modern high pressure valves, strictly first-class and constructed to give satisfaction. Made in standard sizes from two inches up, screw and flange ends, with stationary or rising spindles, with or without yoke and patent by pass, for 175 pounds working pressures.

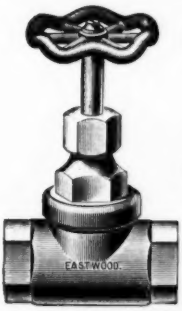
All wearing parts made of bronze. Compact, heavy, durable, low-priced Specify them; they satisfy the most exacting. Write for catalog of high-grade brass and iron engineering specialties.

Injectors, Valves, Whistles, Lubricators, Oil and Grease Cups, Etc.

THE LUNKENHEIMER CO.,

Main Offices and Works, - - CINCINNATI, O., U. S. A.

BRANCHES: { New York, 26 Cortlandt Street. / London, 35 Great Dover Street.



The most extensive
HIGH PRESSURE
VALVE
Manufacturers in United States.
Catalogues Free.

IRON FOUNDRIES,
BRONZE FOUNDRIES,
MACHINE SHOPS,
WIRE WORKS.

Address
Eastwood Wire Mfg. Co.
BELLEVILLE, N. J., U.S.A.

"KENNEDY"

Signifies all that's Good and of the Highest Merit in

VALVES

Send for Catalogue.

A large assortment carried at our New York warehouse.

THE KENNEDY VALVE MFG. CO.,
70 Beekman St., NEW YORK.

CRANE VALVES
ESTABLISHED 1855

FURNACES (OIL, GAS OR COAL.)
FUEL OIL BURNING APPLIANCES.
Write for Catalogs.
ROCKWELL ENGINEERING CO., 26 Cortlandt St., N. Y.

COCHRANE
OIL SEPARATORS.

HORZ. FORM.

VERT. FORM.

IT is not safe to use for boiler-feed purposes the water that drips from a closed heater; this water is condensed exhaust steam, and it is contaminated with the lubricant used in the engine cylinder. Any boiler inspector will tell you that it is dangerous to introduce such oily waters into boilers. Were it not for the oil this water would be well worth saving, because it is hot, and because it is free from scale-forming matter.

In order to save it, all you have to do is to put a

Cochrane Oil Separator

in the exhaust main ahead of the heater. This appliance will take all the oil out of the steam, so that when the steam is condensed, it will be perfectly suitable for boiler-feed purposes.

Have you any idea how much of this pure water you are now throwing away through using a closed heater without an oil separator?

It means, in the average case, about two and a half tons per day of ten hours for every 100 H. P. of steam that you are making.

This is an item against which the cost of a Separator is merely nominal. Thousands of these "COCHRANES" in successful operation.

Ask for Catalogue 6-S.

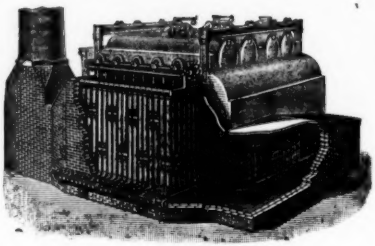
HARRISON SAFETY BOILER WORKS,

3138 N. 17TH STREET, PHILADELPHIA, PA.

It provides a reserve force of boiling water ready for immediate use.

GREEN'S ECONOMIZER

takes the water from the hot well at 110° and heats it to 250°, meeting every sudden demand for power; prevents sediment in boilers by purifying the water; saves ***10 to 20 per cent.*** in fuel; using waste gases entirely, no additional outlay for coal is necessary.



Send for our Free Booklet, "Green's Economizer."

The Green Fuel Economizer Co.

Sole Manufacturers in the U. S. A. **MATTEAWAN, N. Y.**

HEINTZ STEAM TRAP

Now is the time to overhaul your Steam Heating Apparatus. Write us about the merits of the Heintz Steam Saver. We can save you both money and trouble. We guarantee to drain all condensation from your pipes without the loss of any steam. Sent anywhere on 30 days' trial

THE WILLIAM S. HAINES CO.

PHILADELPHIA.

The John Davis Co.,

MANUFACTURERS

Valves, Fittings and Bends

FOR

Extra Heavy Pressures.

MATERIAL FURNISHED TO SKETCH

COMPLETE READY FOR ERECTION.

MANUFACTURERS

Reducing Valves, Back Pressure Valves, Separators and a complete line of Steam Appliances.

Catalogues and Estimates furnished on application.

51 to 79 Michigan Street,

CHICAGO.

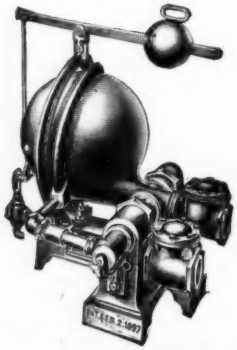
THOROUGH INSPECTIONS

AND

Insurance against Loss or Damage to Property and Loss of Life and Injury to Persons caused by . . . .

Steam Boiler Explosions.

J. M. ALLEN, President.
WM. B. FRANKLIN, Vice-President.
F. B. ALLEN, Second Vice-President.
J. B. PIERCE, Secretary.
L. B. BRAINERD, Treasurer.
L. F. MIDDLEBROOK, Asst. Secretary.



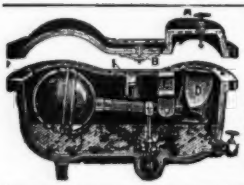
IT IS RARE YOU FIND

a Steam Trap that will work under 250 lbs. of steam pressure. The BUNDY will and does. It is the only one. May cost a little more, but a low price trap is never worth any more than it costs. Most engineers know this and buy the true and reliable BUNDY.

A. A. GRIFFING IRON COMPANY,

New York, Boston, Philadelphia, Jersey City.

Send for book E. M. about Steam Traps, Separators, Feed Water Heaters, Exhaust Heads and Low Water Alarms.

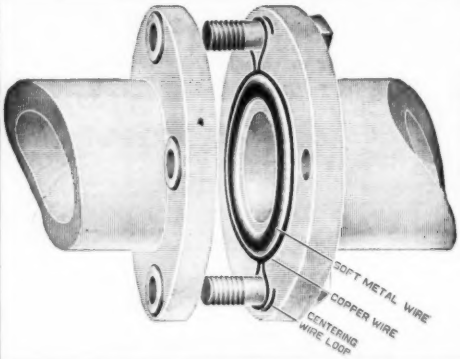


The McDaniel Steam Trap

Discharges continuously and never blows steam.
Made Extra Heavy for High Pressure.

We also Manufacture REDUCING VALVES, EXHAUST PIPE HEADS, SEPARATORS for LIVE and EXHAUST STEAM, BLOW OFF VALVES, RELIEF VALVES, EJECTORS, Etc. *....Send for Catalogue*

WATSON & McDANIEL CO., 142 North 7th Street. PHILADELPHIA, PA.



MERWARTH
PATENTED
Metallic Gasket.

MAY BE USED REPEATEDLY.
EASY TO APPLY.
CHEAPER THAN RUBBER.
WILL STAND HIGHEST STEAM AND WATER PRESSURE.
SEND FOR SAMPLE AND PRICES.

MERWARTH METALLIC GASKET CO.,
107 LIBERTY ST., NEW YORK.

DELAWARE ELECTRIC & SUPPLY CO., Wilmington, Del.
S. J. OSBORN, JR. & CO., Cincinnati, O.
MACAN, JR. & HUNTINGTON, Wilkes-Barre, Pa.
ROCHESTER ENG. & SUPPLY CO., 46 E wood Building, Rochester, N. Y.
THE FAIRBANKS CO., 16, Great Eastern Street, London, E. C.

"Superiority Commands Respect."

The "MONARCH" Engine-Stop System.

"Safe, Swift, Sure."

Over 500 of these SYSTEMS in use on many of the largest plants in this country. With the use of the MONARCH SYSTEM it is impossible for an engine to run away; engine can also be stopped, in case of emergency, from any portion of the plant by pressing an electric button. NO CONNECTION WITH THE GOVERNOR. IT CLOSES THE THROTTLE. INVESTIGATE. Write for 1901 Illustrated Catalogue.

The Monarch Manufacturing Co., Waterbury, Conn.

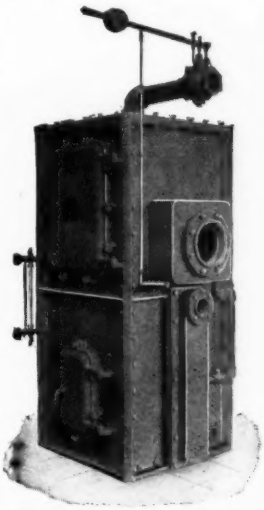
L. W. SWEET (N.A.S.E.), General Manager.

THE E. HOWARD CLOCK CO

Makers of the famous "E. Howard & Co." Watches and Clocks.

TOWER CLOCKS. ELECTRIC CLOCKS.
WATCHMAN'S CLOCKS. PROGRAM CLOCKS.

403, Washington Street, BOSTON 41 Maiden Lane, NEW YORK.



A Class "C" Webster Feed Water Heater, Purifier and Filter.

IF IT WERE NOT

for the improvements in design and construction, the ability to heat more water with less steam; and if the

Webster Feed Water Heaters

did not offer a better return upon the investment, than any other type, from the fact of knowing when and how to apply them properly, they certainly would never have reached their present distinction.

Their scope of merit applies to both condensing and non-condensing plants. Every detail has been developed through years of practical experience. It is the aggregate of details that make up the whole, and upon investigation (which we invite), our heaters will be found satisfactory in all details to the most discriminating buyers.

MANUFACTURED BY

Warren Webster & Company,

Camden, N. J.

PHILADELPHIA: 1105 Stephen Girard Bldg.
NEW YORK: 322 Broadway.
CINCINNATI: 41 Perin Building.
KANSAS CITY: 701 Commerce Building.
ST. LOUIS: 301 Fullerton Building.
DENVER: 822 17th Street
CHICAGO: 1509-10 Monadnock Building.
BOSTON: 729 Tremont Building.
CANADA: Darling Bros. Montreal.

STAR BRASS MFG. CO.

Manufacturers of Extra Heavy
Solid Nickel Seated Pop Safety Valves
for the Highest pressures, both Stationary and Marine type, either Single, Duplex or Triplex style.
Also Original and Exclusive makers of
"NON CORROSIVE" STEAM GAGES.
Recording Gages, Water Relief Valves, Chime Whistles, etc.
Special Pop Valves and Steam Gages for Automobiles.

MAIN OFFICE AND WORKS;
106-116 East Dedham Street, BOSTON, MASS.
NEW YORK, 38 Cortlandt St. CHICAGO, 934 Monadnock Building

Steam Piping for High Pressure Power Plants.

All kinds of Pipe, Globe and Gate Valves, Fittings and Appliances for Steam, Water and Hydraulic Work.

Pittsburgh Valve, Foundry & Construction Company,

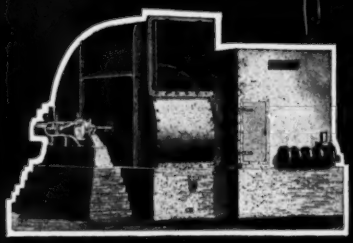
OFFICES:
Duquesne Way and 5th St., Pittsburgh, Pa.

ENGINEERS, FOUNDERS, PIPE FITTERS AND MACHINISTS.

Henry M. Atwood, President.
J. T. Speer, Vice-President.
C. A. Anderson, Treasurer.
Moses Atwood, Secretary and Sales Agent.
Geo. E. Klingelhofer, General Manager.

Please mention The Engineering Magazine when you write.

STURTEVANT SYSTEM
OF
HEATING & VENTILATION



Centralized plant.
No scattered steam piping.
Utilizes exhaust steam.
Operates by positive, forced circulation of warm air.

Send for Catalogue No. 84.

B. F. STURTEVANT COMPANY, BOSTON

NEW YORK PHILADELPHIA CHICAGO LONDON

37

REDUCE YOUR COAL BILLS!

By Putting your water in the Boiler at Boiling Point.

...THE OTIS...
Tubular Feed Water Heater and Purifier,

With Seamless Brass Tubes.

Guaranteed to heat the feed water to the **Boiling Point** (210° or 212°) with the exhaust steam without causing any back pressure. Also to **Extract the Oil** from the exhaust so that the exhaust steam, after being passed through the heater, can be used for heating purposes and the water of condensation from the heating system be returned to the boilers without the extra expense of an additional oil separator or eliminator.

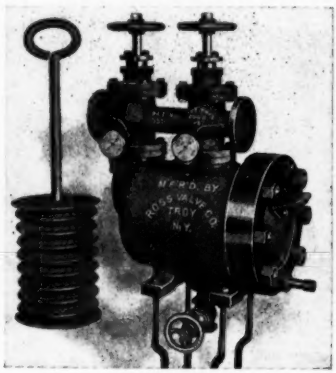
WE GUARANTEE THIS HEATER WILL NOT GET FOUL WITH SEDIMENT.

A LIBERAL OFFER. Try us! If this heater fails to give satisfaction in every respect we will pay freight, cartage and all expenses.

Patented and Manufactured by the

STEWART HEATER COMPANY,
215 NORFOLK AVE., BUFFALO, N. Y.
SEND FOR CATALOGUE.

YOUR BOILER'S GOOD



DEMANDS THAT YOU KEEP OIL OUT OF IT WITH THE

Feed-Water Filter

FOR MARINE OR LAND SERVICE.

Ask for full descriptive circular giving a list of important vessels using this filter.

THE ROSS VALVE CO., TROY, N. Y.

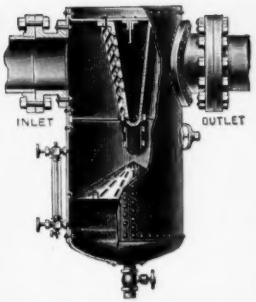


FIG. D. HORIZONTAL.

AUSTIN SEPARATOR COMPANY
26 Woodbridge St.
DETROIT, MICH.

Steam Separators

WE'LL BOTH BE SATISFIED

When your STEAM PLANT is equipped with

Austin Separators

The kind that eliminate all condensation from live steam—all oil, grease and other impurities from exhaust—the safest, surest, best separator on the market.

We ship to responsible parties on 30 days' trial, to be returned at our expense if not satisfactory.

Oil Separators

L. L. CLINE Adv. Dpt.

THE REASONS

...FOR...

SWEET'S SEPARATOR RESULTS are plain if you will investigate. Send for Catalog and read our story. See if it is sensible. Look the tests over, the *painstaking* users' list, and remember our *standard* machines did this. . . .

50% OF ALL SEPARATORS SOLD PAST THREE YEARS HAVE BEEN ON DUPLICATE ORDERS.

We also make
A GOOD EXHAUST HEAD.

Direct Separator Co.,
218 Geddes St., SYRACUSE, N.Y.

Steam or Oil, All Styles.

The Only One

All Separators have their merits. But the

Stratton Separator

is *the only one* that will take care of a large influx of water, positively separate it from the steam, and keep it separated, and so long as the drain pipe is open no water will be again picked up and carried to the engine. That involves considerably larger proportions and higher first cost. But it is a wise investment — you get your money back over and over again.

"Dry Steam" is the title of our new pamphlet—written by a distinguished engineer—worth money to every intelligent reader. Free to all parts of the world on request.

Goubert Manufacturing Co.,
85 Liberty St., - New York, U. S. A.

THE

"A B C" Ventilating Fans

deliver from one-third to one-half more air than others. This fact, and their superior strength, durability and handsome appearance, all urge their adoption. . . .

Descriptive Catalogue on request.

American Blower Co., DETROIT, ...MICH.

NEW YORK: 141 Broadway.
CHICAGO: Marquette Building.
LONDON: 70 Gracechurch Street.

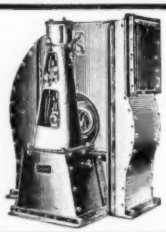
MECHANICAL THERMOMETERS

HOHMANN & MAURER MFG. CO. ROCHESTER, N.Y. TRADE H&M MARK

For all *Engineering Manufacturing and Scientific Uses.* Send for Illustrated Catalogue. Also state your Particular Requirements.

HOHMANN & MAURER MFG. CO.,
32 Elizabeth Street, . . ROCHESTER, N. Y., U. S. A.

LONDON: 103 Hatton Garden.
NEW YORK: 85 Chambers Street.



Boston Blower Co.,

Fan and Pressure Blowers,
Exhaust Fans, **For all uses.**

Hot Blast Heating Apparatus,
Dry Kiln Outfits,
Steam and Electric Fans, Forges,
High and Low Pressure Engines.

HYDE PARK, MASS.

CRUMLISH PORTABLE FORGES

FOR ALL PURPOSES.

Compressed Air Forges.

SEND FOR CATALOGUE.

CRUMLISH FORGE CO., BUFFALO, N. Y.

The Williams Automatic Safety Feed-Water Regulator.

Your Coal Bills Reduced! Boiler and Engine Power Increased!

Less labor to have correct water line continuously than to run the pump. The cheapest kind of boiler and engine insurance. If you do not use them you pay their cost every few months in extra coal bills.

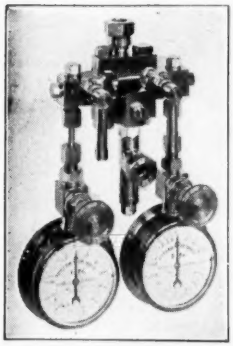
DO YOU WANT DRIER STEAM? If so, use

The Williams Automatic Safety Feed-Water Regulator.

We also manufacture **Safety Columns, Regrinding Gauge Cocks and Steam Traps. "BEST ON EARTH."**

THE WILLIAMS GAUGE COMPANY, ... W. Pittsburg, Pa.

Please mention The Engineering Magazine when you write.



The Ripper Patent Mean Pressure Indicators,

Improved Thompson Steam Engine Indicator,
Reducing Wheels, Planimeters,
Carpenter's Calorimeter for Coal and Steam,
Pressure Gauges for all Purposes,
Engine Registers and Counters, etc., etc.

Manufactured and Sold by

SCHAFFER & BUDENBERG,

Works and General Offices, Brooklyn, N. Y.

WESTERN BRANCH, - NO. 15 W. LAKE ST., CHICAGO, ILL.

Parting Pulleys.

GEO. V. CRESSON CO.,

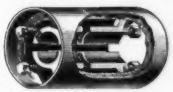
POWER TRANSMITTING MACHINERY.

SHAFTING—PULLEYS.

Sprocket Wheels.

Spur and Bevel Gears.

HANGERS,
ROCK BREAKERS.
CRUSHING ROLLS.



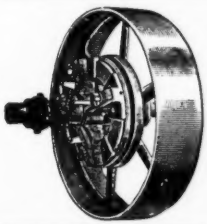
PULLEYS,
MACHINE MOULDED
and CUT GEARING.

Rope Wheels a.l sizes

Patent Internal Clamp Couplings.

ROPE DRIVING A SPECIALTY.

18th ST. and ALLEGHENY AVE., PHILADELPHIA, PA.,
141 LIBERTY ST., NEW YORK.



Friction Clutches and Friction Pulleys

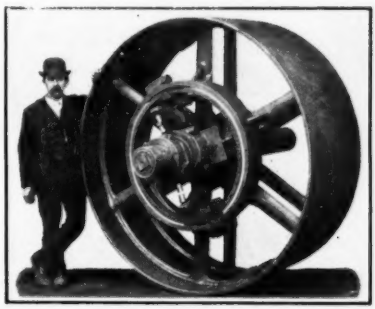
FOR EVERY KIND OF SERVICE.

THOUSANDS IN OPERATION.

MORE THAN 20 YEARS' EXPERIENCE.

Write for Friction Catalogue.

The Eastern Machinery Co., **New Haven, Conn.**



The "Jacobson" Friction Clutch Pulleys and Cut-off Couplings....

For POWER PLANTS, PAPER MILLS, GAS ENGINES, or any other place where a first-class Clutch is required.

We make a line of Air Compressors, Gas Regulators, and all kinds of power transmission machinery.

JACOBSON MACHINE MFG. CO.,

Send for Circulars and discounts. **WARREN, PA.**

See our Exhibit at the Pan-American.

Don't Pay so Much for Fuel.

Your Fuel Bills are larger than those of the man who has our Automatic Smoke Preventer and Fuel Economizer under his boilers.

A large percentage of your heat energy goes up the chimney in smoke, while in his case all the smoke-making carbons and free carbons are utilized as fuel.

If getting all the profit possible out of your plant is any object to you, send for our free booklet:

"THE PASSING OF SMOKEVILLE."

It is interesting whether you are seriously considering our proposition or not.

THE SMOKE PREVENTION COMPANY OF AMERICA, 66 BROADWAY, NEW YORK.

JUST PUBLISHED.

A CATECHISM ON THE COMBUSTION OF COAL

AND THE PREVENTION OF SMOKE.

A Practical Treatise for Engineers, Firemen, and all others interested in Fuel Economy and the Suppression of Smoke from Stationary Steam Boiler Furnaces and from Locomotives.

By WILLIAM M. BARR, M. E.

AUTHOR OF "BOILERS AND FURNACES," ETC., ETC.

One Volume—350 pages—85 Engravings. PRICE, $1.50.

THE ENGINEERING MAGAZINE, • 120-122 Liberty St., New York.

Please mention The Engineering Magazine when you write.

THE BABCOCK & WILCOX CO.

85 LIBERTY ST.
NEW YORK
CABLE ADDRESS
NEW YORK
"GLOVE BOXES"
ALL FOREIGN OFFICES
"BABCOCK"

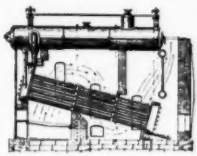
STEAM

WATER TUBE BOILERS

SEND FOR OUR BOOK "STEAM"

BRANCH OFFICES

BOSTON 38 FEDERAL ST.
PHILADELPHIA NORTH AMERICAN BLDG.
SAN FRANCISCO 32 FIRST ST.
CHICAGO MARQUETTE BLDG.
NEW ORLEANS 339 CARONDELET ST.
PITTSBURGH EMPIRE BLDG.
CLEVELAND CUYAHOGA BLDG.
ATLANTA, GA. EQUITABLE BLDG.
MEXICO CITY 7 AV ENIDA JUAREZ
HAVANA, CUBA 116½ CALLE DE LA HAVANA



Hammond Water Tube Boiler.

SEND FOR CATALOGUE.

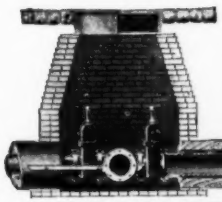
HAMMOND IRON WORKS, - WARREN, PA.

Boilers, Stacks, Water Towers, Tanks

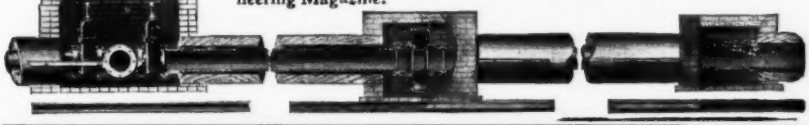
N. Y. Office, 85-89 Liberty St. OF ALL KINDS.

AMERICAN DISTRICT STEAM CO., LOCKPORT, N. Y.,
ORIGINATORS AND BUILDERS OF

Holly System of Underground Steam Distribution



for the utilization of Exhaust Steam from Electric and Power Plants for Heating Purposes. One hundred and seventy-five plants in operation. Also manufacturers and jobbers of Steam Fittings, Steam Traps, Condensation Meters, Valves, Cooling Coils, Steam Separators and Steam Fitters' Supplies. Write for our Pamphlet. Mention Engineering Magazine.



THE ATLANTIC WORKS, EAST BOSTON

STATIONARY BOILERS BUILDERS OF PENSTOCKS, DIGESTERS
TANKS, KIERS.

MACHINERY & PLATE-IRON WORK OF EVERY DESCRIPTION.
ALSO STEAM YACHTS, MARINE ENGINES & BOILERS, MARINE RAILWAY.

CRANE FITTINGS

ESTABLISHED 1855

Please mention The Engineering Magazine when you write.

A Hard Drive.

With solid packings much power is used in simply overcoming the friction of the packing on the rod.

Pack the engine once with "P. P. P," and you will be surprised to see how much less power it takes to drive it. Less power—less coal—less cost.

Daniel's "P.P.P." Packing

is the original "wedge packing," totally different in principle from all others (except the imitations which infringe our patent, and which you'd better not risk using). Its sliding wedges adjust themselves to the rod with the least possible pressure. It saves power, saves packing, saves labor.

The chief engineer for Forbes & Wallace, Springfield, Mass., writing about his experience with "P. P. P." Packing, says:

"A carefully conducted test, covering a long period of time, showed a saving in my coal bill of $104 05 per annum, on one 12½ x 12-inch engine, which is due to reduced friction on the rod, and less power required to run the engine packed with your packing."

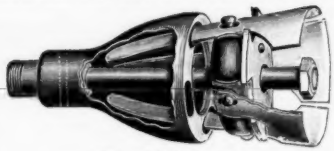
"P. P. P." is sold by the best dealers everywhere. Send for booklet.

Manufactured only by

Quaker City Rubber Co.
PHILADELPHIA.

HF

NEEDED IN EVERY BOILER ROOM.



Patented May, 1901.

ROLLINS'
SELF-EXPANDING
FLUE CLEANER.

EFFECTIVE IN
Smoke Flues or Water Tubes.
DURABLE. SIMPLE.

Write for price list.

STEPHENSON MFG. CO.,
Makers of Stephenson Bar Belt Dressing,
ALBANY, N. Y.

MASSACHUSETTS FAN COMPANY
MNFRS. OF VENTILATING FANS
FOR ALL PURPOSES.
BOSTON, MASS. U.S.A.

Steam-boiler Economy.

A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers.

BY

WILLIAM KENT, A.M., M.E.,

Author of "The Mechanical Engineer's Pocket-Book"

8vo. xiv + 458 pp., 134 figures.

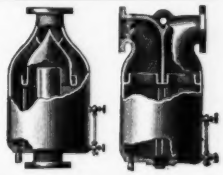
CLOTH, $4.00.

THE ENGINEERING MAGAZINE,
120-122 LIBERTY ST., NEW YORK, N. Y.

Please mention The Engineering Magazine when you write.

Old Colony
TRADE MARK
GEO·B·CARPENTER & CO.
CHICAGO.
NONE SO GOOD FOR THE PRICE.
NONE BETTER AT ANY PRICE.
ESTD. 1840
ALL SIZES FROM ½ TO 2" IN DIAMETER IN LENGTHS UP TO 3000 FT. IN STOCK.
TRANSMISSION ROPE

Every Mill Man
Should Keep Posted by Reading
Power and Transmission
a unique publication in trade literature exclusively devoted to
MODERN POWER TRANSMISSION ENGINEERING
Copiously illustrated with typical installations. Other articles of interest to the up to date factory are also contained in each issue. Sample copy free by applying to
THE DODGE MANUFACTURING CO. ENGINEERS FOUNDERS MACHINISTS MISHAWAKA, IND. U.S.A.
BRANCHES ~ BOSTON NEW YORK CHICAGO CINCINNATI ATLANTA LONDON, ENG.

Hoppes
FEED-WATER HEATERS, STEAM SEPARATORS.

LIVE STEAM FEED-WATER
PURIFIERS
CATALOG FREE.
Guaranteed to Keep Boilers Clean and Free from Scale.
THE HOPPES MFG. CO.,
63 LARCH ST., SPRINGFIELD, O.

THE MIETZ & WEISS ENGINE
GAS OR KEROSENE—Constant Trust
Safe. Simple. Economical. Automatic. Close Regulation.
Direct Coupled or Belted to Generator and all POWER PURPOSES. 1 to 40 Horse Power.
Send for Catalogue.
MARKT & CO. LTD. LONDON, PARIS, HAMBURG AND BERLIN.
A. MIETZ, 128-138 Mott St., NEW YORK.

AMERICAN ORDNANCE COMPANY
Having exceptional facilities, we are prepared to manufacture in quantities from drawings furnished us
SPECIAL MACHINERY
ENGINES FOR MOTOR VEHICLES,
Parts strictly interchangeable.
AMERICAN ORDNANCE CO., BRIDGEPORT, CONN.

Boston Belting Co.

Established 1828.

MANUFACTURERS OF . . .

RUBBER GOODS.

SUPERIOR IN QUALITY.

SATISFACTORY IN SERVICE.

High grade Rubber Belting, of all widths and plies, for the Transmission of Power and for Use as Carriers.

HOSE

FOR

Water, Steam, Air, Gas, Suction Purposes, Fire Protection, Oil, Pneumatic Tools.

Forsyth Combination Packing.

PATENTED APRIL 11, 1899.

A Metal Packing with Elastic Surfaces.
FLEXIBLE AND DURABLE.

When it's about . . . .

RUBBER

ASK US.

Write for our New Mechanical Rubber Goods Catalogue.

JAMES BENNETT FORSYTH, Mfg. Agent and Gen. Manager.

BOSTON. NEW YORK. BUFFALO. CHICAGO. ST. LOUIS.
NEW ORLEANS. SAN FRANCISCO. LONDON.

Big Belts.

Schieren Makes Them.

No matter how large a belt you want SCHIEREN can supply you. We make a specialty of MAIN DRIVING BELTS, for use in MILLS, FACTORIES, GENERATOR WORK on STREET, RAIL ROADS, etc., and carry all sizes up to 60 in. 3-ply constantly on hand to supply emergency orders. We also make Small Belts, Flat, Round or Twisted.

"Belt Lacing."

We tan our own leather and know what our belts are made of—there are no better belts, so get in communication with us at at once.
We guarantee our goods.

Chas. A. Schieren & Co.

New York. Boston. Philadelphia. Chicago. Pittsburg. Denver.
TANNERIES: BRISTOL, TENN.

Tanners and Belt Makers.

WHEN YOU ARE READY to buy a FEED WATER PURIFIER

BUY THE BEST THING KNOWN.

...A Good Water Softening Plant

is the best FEED WATER PURIFIER known, but a POOR Water Softening plant is no better than an exhaust steam heater.

WE MAKE GOOD ONES ONLY.

THE WEFUGO COMPANY, Smith and Augusta Streets, CINCINNATI, OHIO.

APPARATUS FOR THE

Softening and Purification of Boiler Water

Before it enters the Feed-Water Heater, so that it will NEITHER SCALE, CORRODE nor FOAM

FOR PARTICULARS ADDRESS **INDUSTRIAL WATER COMPANY** 15 WALL STREET NEW YORK

10,000 Boiler Feed Waters are being Treated by Dearborn Methods

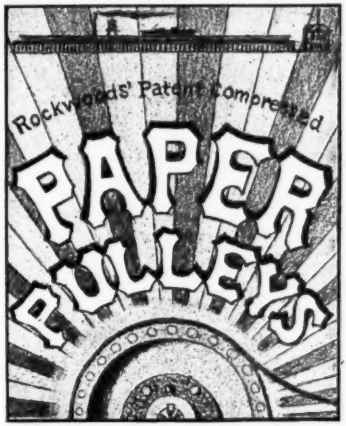
SEND us a jug of your feed water for analysis and let us prepare you a compound to suit.

DEARBORN DRUG AND CHEMICAL WORKS,

Manufacturing and Analytical Chemists. Makers of Boiler Compounds.

29, 30, 31, 32 & 33 RIALTO BUILDING, CHICAGO, ILL.

Please mention The Engineering Magazine when you write.



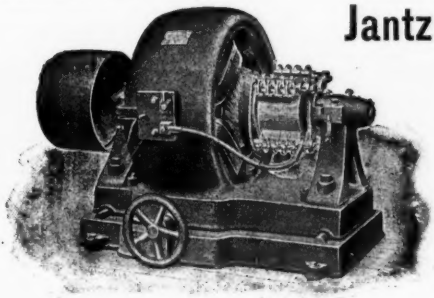
ARE now found on the better makes of electrical apparatus and other high-class machinery, having, on account of phenomenal merit, been adopted as standard by the builders of such apparatus.

We are also extensive manufacturers of iron and paper frictions, paper friction fillers, paper polishing wheels and apparatus for engaging and controlling friction gearing.

The Rockwood Manufacturing Co.,

(New Works 1801-2001 English Ave.) P. O. Box 462 (A)

Catalogue for asking. INDIANAPOLIS, IND., U. S. A.



Jantz & Leist Electric Co.,

Manufacturers of High Grade

Multipolar Motors and Dynamos.

Standard sizes from 1½ to 100 K. W., 110, 220 and 500 Volts.

Motors designed for Direct Connection to all kinds of machinery.

Special Dynamos for Electrotypers and Platers.

(From 1 to 6 Volts and from 200 to 2,500 Amperes.)

808 and 810 Elm Street, - Cincinnati, Ohio, U. S. A.

SPECIFY "EDDY"

ELECTRIC GENERATORS AND MOTORS for any building requiring electrical apparatus of the highest economy and excellence. The EDDY GENERATORS are built direct-coupled or belted.

Consulting engineers and architects may receive EDDY illustrated bulletins regularly by filing their names and addresses at the Windsor office.

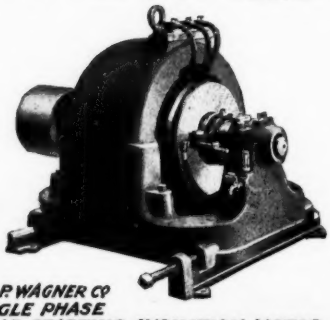
Special information cheerfully supplied.

THE EDDY ELECTRIC MANUFACTURING CO., Windsor, Conn.

NEW YORK: 149 Broadway. CHICAGO: Marquette Building.

WAGNER

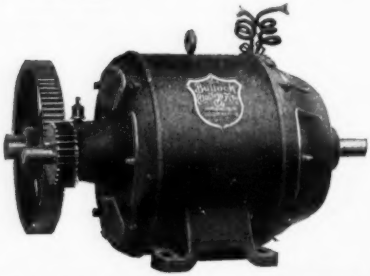
SINGLE PHASE MOTORS FOR ALTERNATING CURRENT



10 H.P. WAGNER CO SINGLE PHASE SELF STARTING INDUCTION MOTOR.

Eminently adapted to all services where a constant speed motor can be used. Can be run from any phase of two or three phase circuits. No complicated starting mechanism. Can be started from a distance. Admirably adapted to pumping service.

BULLOCK



25 H.P. DUST PROOF BULLOCK MOTOR.

DUST PROOF MOTORS FOR DIRECT CURRENT

These motors are especially designed for service in damp or dirty places. They may be operated under conditions that would prohibit the use of an open motor.

SALES ORGANIZATION

BULLOCK ELECTRIC MFG. CO. CINCINNATI, O.

U. S. A.

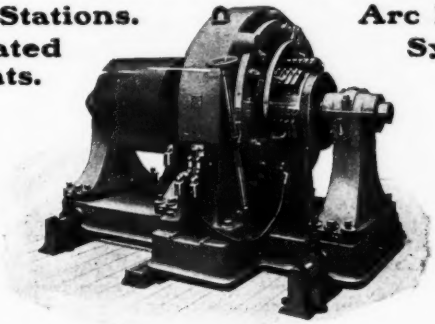
WAGNER ELECTRIC MFG. CO. ST. LOUIS, MO.

293

FRANKLIN CO.—CHI.

WESTERN ELECTRIC GENERATORS

Central Stations. Isolated Plants. **Arc Lighting Systems.**



Write for Bulletin.

Western Electric Company,

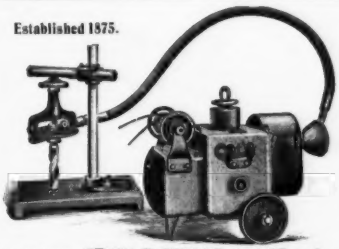
Chicago. St. Louis. Philadelphia. New York.

AMERICAN ELECTRIC CO., St. Paul, Minn.
STANDARD ELECTRIC CO., Cincinnati, Ohio.
CALIFORNIA ELECTRICAL WORKS, San Francisco, Cal.
KILBOURNE & CLARK CO., Seattle, Wash.

Antwerp. London. Paris.

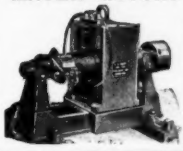
TRADE G·I· MARK
INCANDESCENT LAMPS
FOR ELECTRIC LIGHTING
MANUFACTURED BY THE
GENERAL INCANDESCENT LAMP CO.
39-47 East Prospect St., CLEVELAND, O.

Established 1875.



COMBINATION OF **STOW FLEXIBLE SHAFT and MULTI-SPEED ELECTRIC MOTOR.** Practically dust and water-proof. For Portable Drilling, Tapping, Reaming, Emery Grinding, etc. Write for Catalogue and Prices. **STOW MFG. CO.,** BINGHAMTON, N. Y. General European Agents, Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, England.

MAYER MOTORS AND DYNAMOS



For LIGHT, POWER and PLATING, are efficient, simple and reliable. Guaranteed.
USED BY
Cutler-Hammer Mfg. Co.
Cortland Carriage Gds. Co.
Send for Bulletin and Prices
M. M. MAYER ELEC. CO.,
2363 2d Av., New York.

TWO TELEPHONES, PARK & FARR, 118 W. Jackson Blvd.
BATTERY CALL, FOR $4.50
GENERATOR CALL, FOR 7.50

The American Watchmen's Time Detector Co.'s
Magneto System, Battery System,
FOR NIGHT WATCHMEN
More than TWELVE THOUSAND in use. Seven years' guarantee.
Electric Time System, Master **Clock** and Secondaries. *School Program System. Fire Alarm System. Interior Telephone System. Employes Time Recorder.* Be sure to get our prices. J. S. MORSE, Treas.
Established 1882.
Cable address, JAMINMORSE.
234 & 235 Broadway, New York, N.Y.

Consult the Engineering Index in this Number.

Please mention The Engineering Magazine when you write.

100 K. W. Generator.

OUR LINE OF "C & C"

Electrical Machinery

Includes the most modern and approved types of Generators and Motors for direct-connection, belting or gearing. Slow and moderate speeds.
Open and Enclosed Type Motors.
Generating Sets, Electric Hoists, Exhausters.

SEND FOR DESCRIPTIVE BULLETINS.

The C & C Electric Co.,

143 LIBERTY ST., NEW YORK, U.S.A.

London Office : - - Albany Buildings, Westminster, S. W.

ELECTRICAL... CONTROLLERS

...FOR...

Cranes, Elevators, Hoists, Tools and Special Machinery.

SCHUREMAN & HAYDEN, 138 So. Clinton St., CHICAGO.

The Organization of Gold Mining Business.

WITH SPECIMENS OF THE DEPARTMENTAL REPORT BOOKS AND THE ACCOUNT BOOKS.

By NICOL BROWN.

THE METHOD of organization embodied in this excellent work is the result of a vast and varied experience acquired by the author during his connection with numerous Mining and Metallurgical Companies. The dominant object of the treatise is to lucidly systematize the records of the working or technical end of the business or commercial departments, so that the head officials and responsible officers may easily comprehend and follow the results recorded by each other, and that the whole system of departmental reports and accounts may be so fitted in and dovetailed together as to be rendered intelligible to any Board or Committee.

With diagramatic arrangement of a complete set of books showing their relation to each other. With full size sample pages showing ruling and arrangement of each book. Order blanks, receipts, and other printed forms, etc., etc.

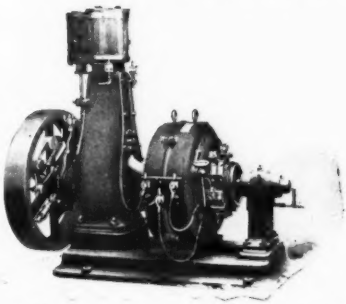
Size of book, 13½x8¾ inches, cloth $10.00

THE ENGINEERING MAGAZINE PRESS,
120-122 Liberty Street, New York, U.S.A.

DIRECT CONNECTED

MARINE GENERATING SETS.

LEAST WEIGHT AND ATTENTION.



MOST PERFECT SERVICE.

OUR Generators and Motors are the best for marine work. They have the highest efficiency, are the most durable, occupy the least space and are economical in current consumption Send for Catalogue No. 01100 and Bulletin 01206.

SPRAGUE ELECTRIC CO.

General Offices: 527-531 WEST 34th STREET, NEW YORK.

Branch Offices:

CHICAGO, Fisher Building. BOSTON, 275 Devonshire St. ST. LOUIS, Security Building. BALTIMORE, Maryland Trust Buiding.

Mangin Mirror Projectors and.... Reflector Search Lights.

ANY CANDLE POWER.

CHAS. J. BOGUE, 211 Centre Street, New York.

TELEPHONE 2111 SPRING.

ONONDAGA.

Enclosed Motors.

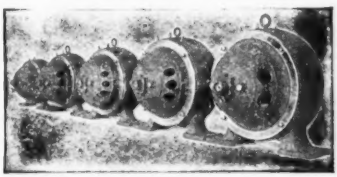
COMPACT EFFICIENT DURABLE.

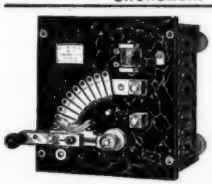
Dynamos and Electrical Apparatus.

MANUFACTURED BY

Onondaga Dynamo Co.

Syracuse, N. Y.





MERIT is what has brought C & H rheostats to the front and what keeps them there. The high quality of material and workmanship sells them. Their perfect operation keeps them sold and sells more.

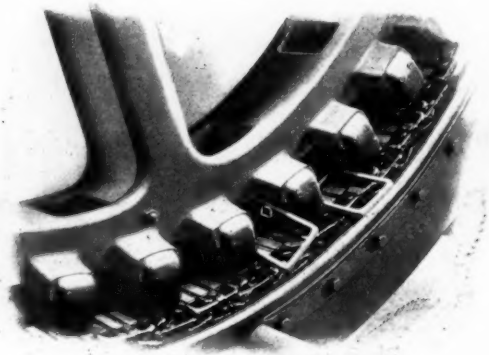
Send for illustrated catalogue No. 565.

THE CUTLER-HAMMER MFG. CO.,

MILWAUKEE, WIS. WESTFIELD, N. J. NEW YORK, N. Y.

The largest and oldest exclusive manufacturers of electric controlling devices in the world.

Please mention The Engineering Magazine when you write.



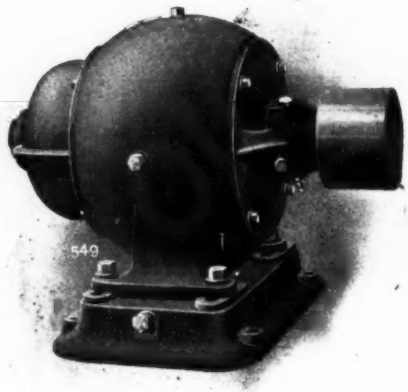
The Replacing of an Armature Coil....

in an S.K.C. Inductor type Generator is accomplished with great facility.

This type of machine possesses neither brushes, collectors, nor moving wires of any kind. Its construction is such that mechanical wear and tear is reduced to the simplest known mechanical movement, a shaft revolving in bearings. A very important consideration also is that no future improvements can make it too expensive to operate.

Stanley Electric Mfg. Company,

Pittsfield, Mass.



The DUST PROOF type of

Northern Motor

will find favor with many operators of machinery for work which would quickly render any other type useless.

The motor illustrated here is a little giant for hard work and service. It is dust, splinter, splatter, steam, vapor and tool proof. Put them anywhere, right side up or upside down, either belted, geared, or direct-connected to machine. We also build them for ***vertical*** operation. We have equipped some of the largest manufacturing plants in America for electric-drive and lighting. We solicit correspondence from manufacturers in all lines. Ask for Bulletin No. 244.

Generators and Motors for Direct or Alternating Current.

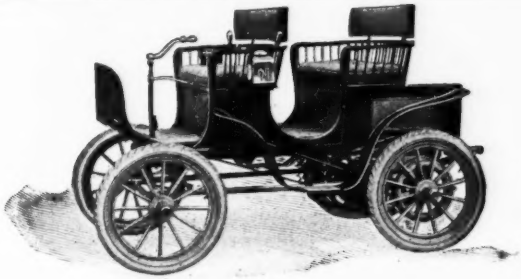
Northern Electrical Manufacturing Co.,

STANLEY ELECTRIC MFG. CO., Pittsfield, Mass. MADISON, WIS., U. S. A.

Columbia AUTOMOBILES.

ELECTRIC. GASOLENE.

In Sixth Year of Successful Service.



Mark XIX Columbia Surrey.

Improved 1901 Electric Models,

FOR PROMPT DELIVERY.

Forty Miles on Single Charge of New Exide Batteries.

1901 Illustrated Catalog and Price List on request.

Selling Agencies:

New York Electric Vehicle Transportation Co., 8th Avenue and 49th Street, New York City, N. Y. Buffalo Branch: 240 West Utica St., Buffalo, N. Y.
Westchester Motor Vehicle Co., Larchmont, N. Y.
Newark Motor Vehicle Co., 27 Mechanic Street, Newark, N. J.
New Jersey Motor Carriage Co., Plainfield, N. J.
Paterson Wagon Co., Paterson, N. J.
New Jersey Electric Vehicle Transportation Company, Allenhurst, N. J.
John H. Schmidt Co., Morristown, N. J.
Hartford Automobile Station, Hartford, Conn.
J. J. Mandery, 150 South Ave., Rochester, N. Y.
E. G. Hayward, 100 Bellevue Avenue, Newport, R. I.
Pennsylvania Electric Vehicle Co., 250 No. Broad Street, Philadelphia, Pa.
Washington Electric Vehicle Transportation Co., Panorama Building, Washington, D. C.
H. S Sands Electric & Mfg. Co., Wheeling, West Va.
L. G. Martin Co., Duquesne Way and Fourth Street, Pittsburg, Pa.
Cleveland Automobile and Supply Co., 144 Prospect Street, Cleveland, O.
General Western Agency: M. J. Budlong, 267 Wabash Avenue, Chicago, Ill.
Henry S. Turner, 1015 Olive St., St. Louis, Mo.
Toledo Motor Carriage Co., 713 Jefferson Street, Toledo, Ohio.
Detroit Riker Automobile Co., 250 Jefferson Street, Detroit, Mich.
The Automobile Co. of New Orleans, New Orleans, La.

In territory not represented by Agencies all communications should be addressed to

Electric Vehicle Company,

100 BROADWAY, NEW YORK.

AIR COMPRESSORS

OF ALL SIZES--FOR ALL PURPOSES.

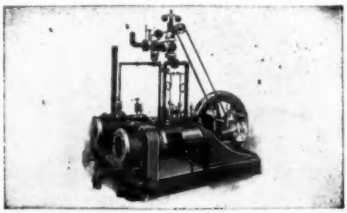
Rock Drills.

SERGEANT DRILL.

Coal Cutters.

Class "H" Air Compressor

is built Compound and Non-Compound and will be found highly suited for : : : : : : : : : :



Ingersoll-Sergeant Class "H" Compound Compressor.

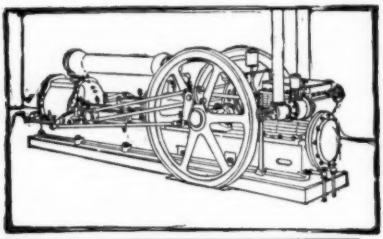
General Manufacturing, Railroad Shop, and Mining Work

everywhere. Being a new design we have combined in it all the best developments in late Steam and Pneumatic Engineering Practice.

Send for Latest Catalogue.

THE **INGERSOLL-SERGEANT** DRILL CO., 26 CORTLANDT STREET, NEW YORK.

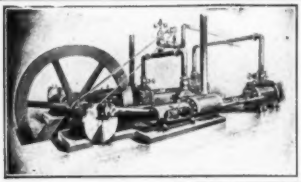
COMPOUND AIR COMPRESSORS



for driving coal cutters, drills, pneumatic tools, locomotives, and for all appropriate purposes. Any pressure. Any volume.

The Norwalk Iron Works Co.,

SOUTH NORWALK, CONN.

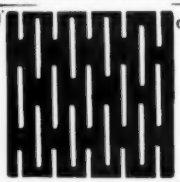


Air Compressors.

We have a very full line of Steam Driven Air Compressors. Send for New Folder. Also . . .

MINE LOCOMOTIVES.

Vulcan Iron Works, Wilkes-Barre, Pa.



PERFORATED SCREENS

OF ALL KINDS FOR

Trommels, Shakers, Undercuts for Sluices, Placer Mining, Mechanical Sluices, power attached, Complete Placer Plants.

BECKLEY PERFORATED SCREEN WORKS,

GARWOOD, N. J.

ROCK DRILLS

THAT GIVE SATISFACTION.

AIR COMPRESSORS

OF THE MOST MODERN TYPES.

ASK ABOUT OUR

"IMPERIAL."

RAND DRILL CO., - 128 BROADWAY, NEW YORK, U.S.A.

DIAMOND

For Prospecting Mineral Lands and Veins.

Take out a solid core, giving perfect sample of material penetrated.

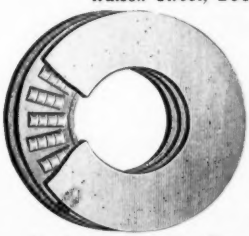
Machines for any depth, and for Steam, Compressed Air, Hand or Horse Power. Send for Catalogue.

AMERICAN DIAMOND ROCK DRILL CO.
120 Liberty Street, New York.

ROCK DRILLS

The Ball-Bearing Company,

Watson Street, BOSTON, MASS.



Manufacturers of...

Ball, Roller, Thrust, Step and all kinds of

Anti-Friction BEARINGS.

Send for Circulars Nos. 20, 21, 24 and 26.

ESTABLISHED 1863.

Phillips Mine and Mill Supply Co.

MANUFACTURERS OF

MINE, MILL AND COKE WORKS EQUIPMENT. . .

PITTSBURGH, PA., U. S. A.

Please mention The Engineering Magazine when you write.

ALLIS-CHALMERS CO.

... SUCCESSORS TO....

THE EDWARD P. ALLIS CO., Milwaukee. GATES IRON WORKS, Chicago.
FRASER & CHALMERS, Chicago. DICKSON MFG. CO., Scranton.

Mining, Milling and Smelting Machinery

Gates Rock and Ore Breakers.

Coal Mining Machinery.

Reynolds Corliss Engines.

BRANCH OFFICES:
NEW YORK. DENVER. SPOKANE.
PITTSBURG. CITY OF MEXICO.
MINNEAPOLIS. LONDON.

GENERAL OFFICES:
CHICAGO, ILL.
HOME INSURANCE BLDG.

PORTABLE DRILLING MACHINES.

Test your Land for Minerals.

We aim to supply the export trade with a thoroughly satisfactory article. Our machines are complete in every particular, and are ***the best made,*** so that there is no chance for breakage and the consequent delay when properly handled.

WATER, MINERALS, OIL OR GAS.

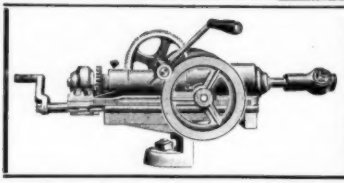
Our machines will discover them if they are there. Pure, wholesome water is a matter of vast importance. It can always be found if you will go deep enough.

THE STAR DRILLING MACHINE

is made in a series of 10 different sizes **for drilling wells from 250 to 2500 feet in depth.** In digging for water the drilled well will be found far more satisfactory than any other. Send for illustrated catalogue.

Cable Address: "STARDRILL."
Use "A-B-C Code, 4th Edition,"
or "Universal Code of Lieber."

STAR DRILLING MACHINE CO.
AKRON, OHIO, U. S. A.



Not an experiment; in general use throughout the World.

The Jackson HAND POWER Rock Drill.

OPERATED by ***one*** man will do the work of three men drilling with single bits and hammers. Guaranteed against breakage for two years. Used for all rock work. In many instances has reduced cost of mining 50 per cent. Write for catalogue

H. D. CRIPPEN, - 52 Broadway, New York, U.S.A.

Induction Coils and Coil Making.

Second Edition, thoroughly revised, greatly enlarged and brought up to latest American Practice.

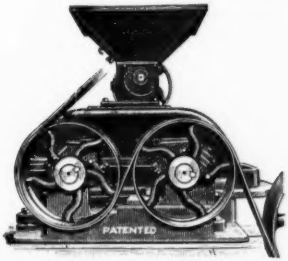
BY H. S. NORRIE,
(NORMAN H. SCHNEIDER).

XII. + 270 Pages, 79 Illustrations, 5 x 6½ Inches, Cloth, $1.00.

THE ENGINEERING MAGAZINE, - 120-122 Liberty St., New York.

Please mention The Engineering Magazine when you write.

CENTRIFUGAL CRUSHING ROLLS



DO **3** TIMES

As much as other Rolls of Equal Dimensions.

SEND FOR CIRCULAR. STURTEVANT MILL CO., 110 Clayton Street, BOSTON, MASS.

A CURIOSITY.

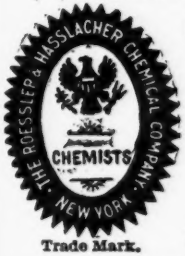
WE DIDN'T GET A PRIZE AT THE PARIS EXPO. DIDN'T EXHIBIT

We're selling without Diamonds.

WE'RE AT 128 B'WAY, NEW YORK.

Davis Calyx Drill Co.

The ROESSLER & HASSLACHER CHEMICAL CO.
100 William Street, New York.



Trade Mark.

CYANIDE

PEROXIDE OF SODIUM
HYPOSULPHITE OF SODA
CHLORIDE OF LIME
SULPHIDE OF IRON

And Other Chemicals for Mining Purposes.

PLATINUM WARE

for laboratory and general chemical purposes for mining assays.

All HAMMERED Work.

CRUCIBLES, ETC., REPAIRED.

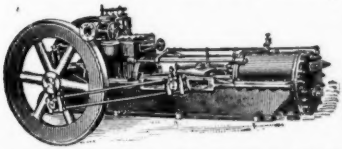
Scrap bought, reworked or exchanged.

J. C. ENTRIKEN, Malvern, Pa.

Consult the Engineering Index in this number.

Simplest and Most Economical

ROCK DRILLS,



AIR COMPRESSORS,

of the Most Improved TYPES.

SOLE AGENTS FOR THE

Kennedy Patent Air Lift.

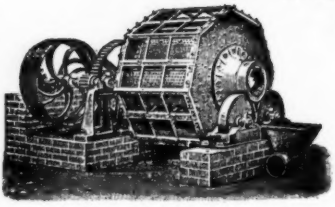
McKIERNAN DRILL CO.

120 Liberty Street, New York.

Please mention The Engineering Magazine when you write.

The Smidth Ballmill

IN ONE OPERATION,



Crushes, Grinds and Sifts,

WORKING CONTINUOUSLY.

Unequalled for uniform product, maximum output, low horse power, ease of access or slight cost of repairs. The Automatic Feeder insures regularity and effectiveness otherwise impossible.

Send for Catalogue.

F. L. SMIDTH & CO., Engineers,

66 MAIDEN LANE, NEW YORK.

BEST, SIMPLEST, MOST ECONOMICAL.

COPENHAGEN: Vestergade 29, K.

LONDON: 9, Bridge St., S. W.

MINERS AND CONTRACTORS READ THIS.

SAVE MONEY BY USING ONLY

NITRO-PLASTINE, *Pat. July 16, 1895.*

NITRO-POWDER, *Pat. July 16, 1895.*

THE ideal high explosives. They are more powerful, less dangerous from accidental explosion, do not freeze as easily as other powders, and do not throw off the obnoxious fumes that the other makes do. Nitro-Plastine is incomparable as a sub-marine explosive. Send small order for trial and be convinced. Prices are no higher than the inferior makes. Send for pamphlet.

NITRO-POWDER COMPANY, Wall Street, KINGSTON, N. Y.

ROLL SHELLS. TELEPHONE 45-13. SEC. S.

BLANTON CAM.

E. A. BLANTON, JR.,

Consulting Engineer,

Mining, Crushing and Milling Machinery, Conveying Machinery, Couplings.

THE BOURSE, *PHILADELPHIA, PA.*

PERFORATED METALS

FOR ALL USES IN MINING & ORE DRESSING

THE ROBERT AITCHISON PERFORATED METAL CO.

CHICAGO, ILL.

We have in Stock and can Ship at once:

One 45 H. P. Tubular Boiler in "knock-down" shape for mule-back transportation, no part weighing over 350 lbs. All the regular fixtures for half-front, including pump, injector and pipe.

One Self-Contained Geared Hoist, very compact, suitable for prospecting or exploiting small mines.
Hoisting capacity 1100 lbs. at 490 ft. per minute.
Drum will hold 3000 ft. of ½ in. rope.

Can ship in one week:

One Self-Contained Geared Hoist, very compact, suitable for hoisting a load of 1700 lbs. at 540 ft. per minute.
Drum will hold 1500 ft. of ⅝ in. rope.

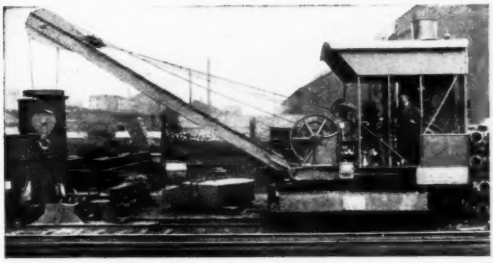
Detailed Specifications and Special Prices on Application.

WEBSTER, CAMP & LANE MACHINE CO.,

AKRON, OHIO, U. S. A.

The Brown Hoisting Machinery Co.,

Main Office and Works
Cleveland, Ohio, U. S. A.



Standard 12-ton Locomotive Crane.

Engineers, Designers and Manufacturers of

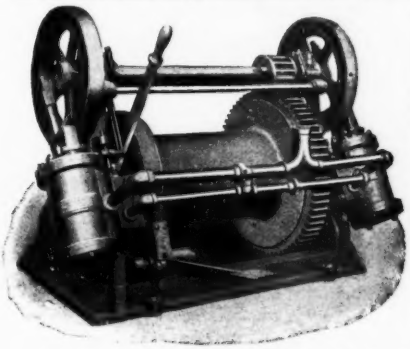
Locomotive Cranes.

NEW YORK.
PITTSBURG.
LONDON.

A "**Brownhoist**" Locomotive Crane around your works can earn its cost in a few months.

Such a crane can carry heavy work from one shop to another, transport flasks from foundry to storage, unload machinery, coal, etc., from cars or vessels. In fact the Crane can do a dozen and one things of which you may never have thought.

It is a perfect Locomotive for Yard Shifting.



BACON'S "SPECIAL"

Double Cylinder Hoisting Engine

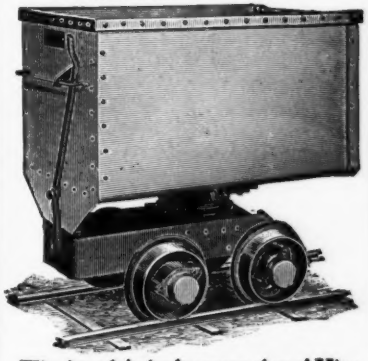
FOR UNDERGROUND USE IN MINES.

Earle C. Bacon, Engineer,
Havemeyer Building, New York.

ONLY ONE.

There is only one Engineering Index; it is a monthly report on the latest progress in engineering practice.

MINE CARS, ORE CARS, LOGGING CARS.



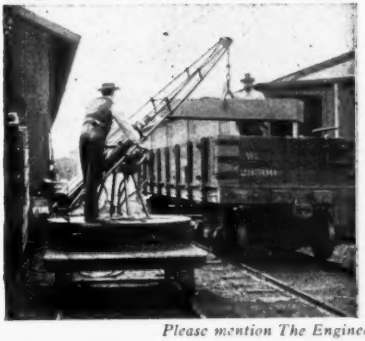
Wheels and Axles for every class of Mine Service. Watt's Self-Oiling Wheels. High Quality of our Work.

Drawings and Estimates furnished for any kind of Mining, Ore or Logging Cars wanted.

EXPORT TRADE A SPECIALTY.

The WATT MINING CAR WHEEL CO.

BARNESVILLE, OHIO, U. S. A.



Garry Revolving Pneumatic Crane.

For handling heavy materials of all kinds.
Very rapid, economical and durable
Especially adapted to loading heavy material on cars or boats.
Useful in all works where heavy lifting is required.
Three men can do the work of eight where our cranes are employed.
Built to any size or capacity, or specially designed if desired. We also make . . .

PNEUMATIC CAR JACKS.

PNEUMATIC PAINTING MACHINES AND AIR HOISTS.

STRUCTURAL IRON WORK.

The Garry Iron and Steel Roofing Co.

CLEVELAND, OHIO.

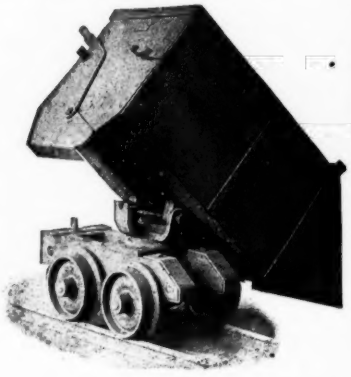
Please mention The Engineering Magazine when you write.

Cars *for* Mine *and* Industrial Uses

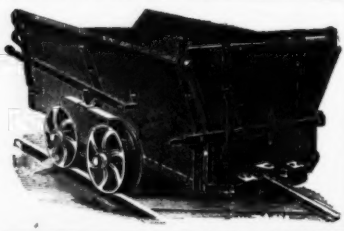
Anaconda
Wheels *and* Axles
are the best ever designed

Cars built for every need and to conform with any specification and drawings

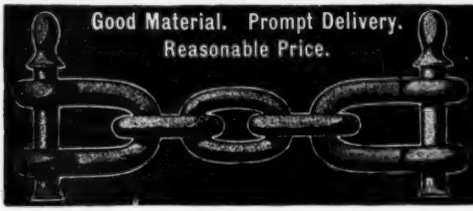
We are glad to make special designs to meet requirements



American Engineering Works
204 Dearborn Street, Chicago, Ill.



Tipples, Screens, Mine Cars, Drums, Larries, Cages,
GENERAL MINE SUPPLIES.
The Niles Mine AND Mill Supply Co.,
Send for latest Catalogue.
WORKS, NILES, OHIO.
GENERAL OFFICE, CLEVELAND, OHIO.



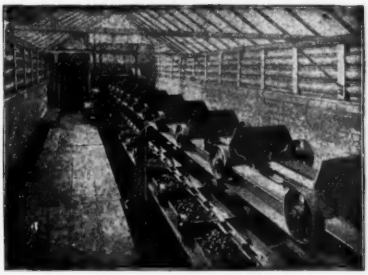
Good Material. Prompt Delivery. Reasonable Price.

Mine-Car Hitchings
WM. HARRIS & SON,
111 FERRY STREET, - PITTSBURG.
It does not pay to make your own Hitchings. We can supply you better and cheaper.
SEND FOR PRICES.

FOR CARD-INDEX USERS

For the convenience of those who desire to preserve indexed items, in card-index from, THE ENGINEERING INDEX is issued separately from the Magazine, printed on one side of the paper. Ask for a specimen of it

JEFFREY COAL HANDLING MACHINERY.



Elevating, Conveying, Power Transmission

MACHINERY.

Also Coal Mining, Coal Washing, Screening, Crushing . . .

MACHINERY.

Send for Catalogue.

THE JEFFREY MANUFACTURING CO.,
COLUMBUS, OHIO, U. S. A.

NEW YORK. CHICAGO. DENVER.

THE EXETER MACHINE WORKS.

Coal Handling Machinery AND High Grade Hoisting Engines,

PITTSTON, PA.

Harrison Conveyor.

Elevators, Shaking Screens.

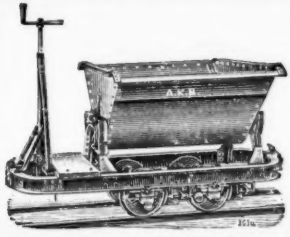
Wholesale and Retail Coal Pockets supplied with complete equipment by which coal is transferred from cars or boats to pocket or yard and from yard to pocket.

NO BREAKING OF COAL—NO NOISE.

Electric Light and Power Station Equipment, Industrial Railways, Overhead Cable Systems, Coal and Ash Conveyors, Overhead Tracking, Switches, Etc., Eccentric Shaking Screens, Roller Screens, Elevators, etc., Shafting, Pulleys, Gearing, Rope Drives, Hangers, Pillow Blocks, Car Movers, COMPLETE TIPPLE HOUSE EQUIPMENT, consisting of Elevators, Conveyors, Coal Crushers, Picking Tables Shaking Screens, Revolving Screens, Car Pullers, Hoisting Engines, Howe Standard Scales, Howe Gas and Gasoline Engines.

For further particulars, catalogues and prices address the manufacturers,

BORDEN & SELLECK CO., - - 48-50 Lake Street, Chicago, Ill.



ARTHUR KOPPEL,

68 Broad Street, New York.

CARS of every description.

All kinds of TRACK material.

Complete INDUSTRIAL RAILWAYS for hand, steam or ELECTRIC power.

STOCK always on hand. Send for Catalogue and Estimates.

41

COAL HANDLING

Our New Illustrated Book mailed on Application.

ROBINS CONVEYING BELT CO., 14-22 Park Row, NEW YORK.

BRODERICK & BASCOM ROPE CO.

...Sole Manufacturers of...

Established 1875.

St. Louis, Mo.

THE MOST DURABLE ROPE MADE. IT HAS NO EQUAL.

SEND FOR ILLUSTRATED CATALOGUE.

Elevating and Conveying Machinery.

Modern methods mean economy.
Our Engineering Department can help you on any special device requiring special treatment.
We make a specialty of Elevating and Conveying Appliances and Power Transmission Machinery, using sprocket chain.
We furnish plans and estimates and supervise construction.
Quick deliveries of high grade Malleable Iron Castings.

BUHL MALLEABLE COMPANY, Detroit, Mich.

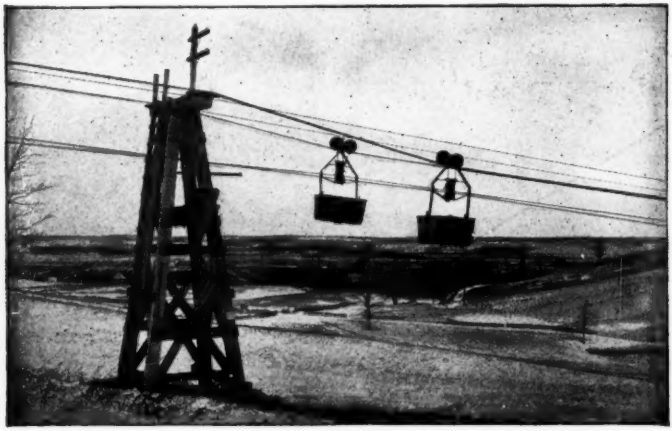
GAS ENGINE CONSTRUCTION.
By HENRY V. A. PARSELL, Jr., and ARTHUR J. WEED, M.E. A practical work describing every detail in the Building of the Gas Engine. Large 8vo.; illustrated; 300 pages. Price, Cloth, $2.50.

GAS, GASOLINE AND OIL ENGINES.
By GARDINER D. HISCOX, M.E. Full of General Information about this motive power, its economy and ease of management. Large 8vo.; 270 illustrations; 365 pages. Price, $2.50.

THE ENGINEERING MAGAZINE PRESS, 120-122 Liberty Street, NEW YORK.

THE BLEICHERT WIRE ROPE TRAMWAY,

AND OTHER SYSTEMS OF AERIAL TRANSPORTATION.



Bleichert Tramway of The Solvay Process Co., transporting rock.

MANUFACTURED BY **THE TRENTON IRON CO.,** TRENTON, N. J.

Engineers and Contractors, and sole licensees in North America for the Bleichert System. Also, Wire Rope Equipments for Surface and Underground Haulage, etc.

New York Office—Cooper, Hewitt & Co., 17 Burling Slip. *Chicago Office*—1114 Monadnock Building.

THOMAS CARLIN'S SONS CO.,

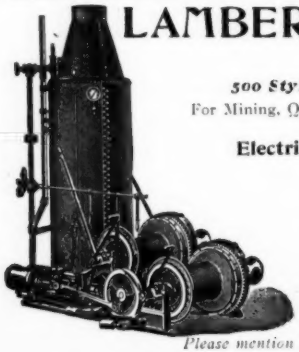
.. Manufacturers of ..

HOISTING ENGINES, DERRICKS AND PILE DRIVERS.

Full Line of Contractors' Machinery and Tools, Second-hand Steam Shovels, Locomotives, Hoisting Engines, etc., on hand.

ILLUSTRATED CATALOGUE FREE ON REQUEST.

ALLEGHENY, PA., U. S. A.



LAMBERT HOISTING ENGINES.

ELECTRIC HOISTS.

500 Styles and Sizes. Built to Gauges and Templates.

For Mining, Quarrying, Coal Handling, Pile Driving, Builders' Use, Logging and General Contracting

Electric Hoists, Single and Double Drums, with Improved Automatic Brake. Suspension Cableways.

Send for new Catalogue A.

LAMBERT HOISTING ENGINE CO.,

Main Office and Works:

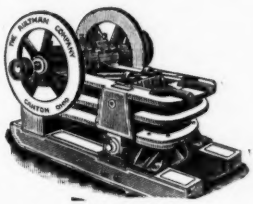
117-123 Poinier Street, Newark, N. J.

New York Office, - - 85 Liberty Street.

Boston, Philadelphia, Chicago, Cleveland, St. Louis.

Please mention The Engineering Magazine when you write.

AULTMAN



ROCK CRUSHER.

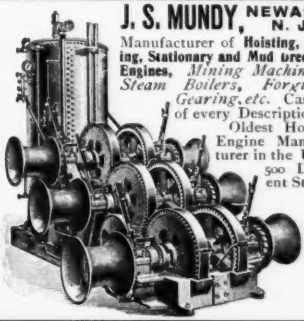
ELEVATING, CONVEYING,
SCREENING AND
ROCK CRUSHING
MACHINERY,
MINE TIPPLES,
CAR HAULS.

For Designs, Prices and Catalogues, address

The AULTMAN COMPANY
CANTON, OHIO, U. S. A.

AULTMAN

J. S. MUNDY, NEWARK, N. J.



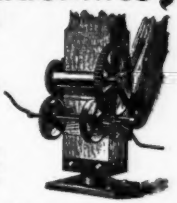
Manufacturer of **Hoisting, Mining, Stationary and Mud Dredging Engines,** *Mining Machinery, Steam Boilers, Forgings, Gearing, etc.* Castings of every Description.

Oldest Hoisting Engine Manufacturer in the U. S. 500 Different Styles.

Send for Catalogue

Hoisting Machines

Steam, Horse and Hand Power.



DERRICK IRON AND CONTRACTORS' SUPPLIES.

A very complete and useful catalogue sent free. Mention this Magazine.

Contractors' Plant Mfg. Co. (Limited),
129 Erie Street, Buffalo, N. Y.

.. Hazard .. Manufacturing Co.

ESTABLISHED 1848.
MANUFACTURERS OF
IRON, STEEL AND GALVANIZED
WIRE ROPE
INSULATED WIRES
UNDERGROUND CABLES
SUBMARINE CABLES
AERIAL CABLES
COPPER WIRE

GENERAL OFFICE & WORKS:
WILKES-BARRE, PA.
NEW YORK: 50 DEY STREET.
CHICAGO:
J. B. WALLACE, 1201 MARQUETTE BLDG.
H. CHANNON CO., 24 MARKET ST.

Founded by Mathew Carey, 1785.

HENRY CAREY BAIRD & CO.,

INDUSTRIAL PUBLISHERS, BOOKSELLERS & IMPORTERS,
810 Walnut Street, Philadelphia, Pa., U. S. A.

☞ Our New and Revised *Catalogue of Practical and Scientific Books*, 92 pages, 8vo, complete to February 1, 1898, and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free, and free of postage to anyone in any part of the world who will furnish his address.

A Card Index

applied to indexing things the engineer wants to refer to. Ask for circular.

THE ENGINEERING MAGAZINE, New York.

BLUE PRINTS

Helps in taking care of Blue Prints, Drawings, Photographs, etc.
Send for Circular.

A. G. BUTLER,
Cor Beekman and Pearl Sts., NEW YORK.

THE C. W. HUNT COMPANY

MANUFACTURE

COAL HANDLING MACHINERY

of many varieties, for handling Coal, Ore, Stone, etc., from the simple Mast and Gaff hoisting from Canal Boats to the most elaborate plant that will unload the largest vessel in one day; Automatic and Cable Railways, Coal Tubs, Steam Shovels, Wheelbarrows, Coal Chutes, Valves and Screens, Coal Crackers, Receiving and Weighing Hoppers, Hoisting Blocks for both Wire and Manila Rope.

CONVEYORS.

Hunt Noiseless Gravity Conveyor, which carries the material in any direction, without shock, breakage or violence, and every bearing arranged to be kept thoroughly lubricated, and the whole machine as durable as an ordinary machine tool.

INDUSTRIAL RAILWAYS.

A special railway, 21½ inches gauge, for use in manufacturing establishments. Every part is specially designed with the idea that a railway for this purpose is as much a "machine" as a "lathe," a "steam hammer," or a "loom," and requires the same care in design, and the same quality of machine work. The track is made up with the steel cross-ties securely riveted to the rails, and, with the switches, curves, crossings, and turntables, is kept in stock ready to lay. The cars are made to suit every variety of service, and have running gear so arranged that they run around a curve of 12 feet radius as easily as a wagon turns a corner. We furnish every part required for the installation of a railway.

STEAM HOISTING ENGINES.

Heavy Duty Engines, with extraordinarily heavy working parts, large wearing surfaces and accurate workmanship. To prevent danger from frost, the steam passages are so arranged that all condensed water automatically drains away.

ELECTRIC HOISTING ENGINES.

Built for heavy and continuous work, from 5 to 150 horse-power, and having drums, clutches, brakes, and other parts corresponding to those usually used with steam hoisting engines.

MANILA ROPE.

This rope is made for **Rope Driving and Hoisting only,** and is sold under the trade name of **"Stevedore."** We guarantee that **more work** can be done with it, in proportion to its cost, than with any other rope in the market, without any exception whatever, and will gladly refund the difference in price if it is not all we claim

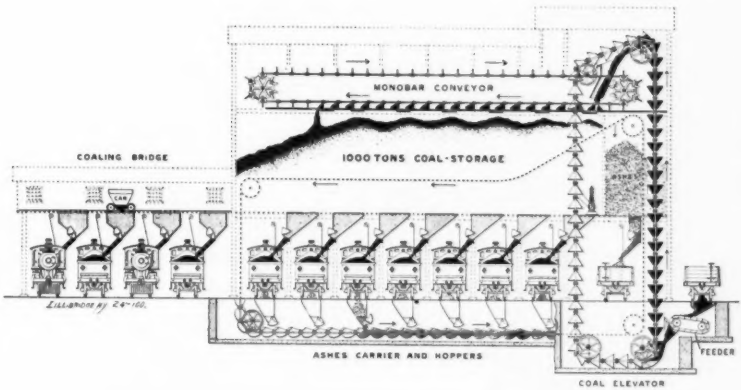
We have spent 27 years in this work.

We manufacture and guarantee the material and workmanship of every article we sell.

We shall be pleased to furnish full particulars upon application.

Address, C. W. HUNT COMPANY,
Cedar Street, West New Brighton, N. Y.

Please mention The Engineering Magazine when you write.



Coal Handling on the P. & R.

This is the "Subway" Plant under Pennsylvania Avenue, Philadelphia, and represents one of the largest locomotive coaling equipments extant.

ELEVEN Locomotives can simultaneously take coal, and seven of them dump ashes, while, at the same time, coal is being elevated to the bins and ashes discharged into cars. . . . . .

The coal pocket has a capacity of 1,000 tons and the machinery will handle 120 tons of coal and 20 tons of ashes per hour. . . . . .

Further details in this interesting installation will be gladly furnished to those interested, upon request.

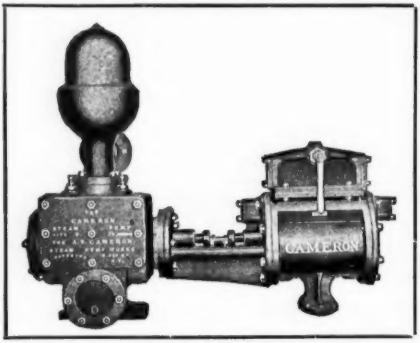
Link-Belt Engineering Co.

NICETOWN, PHILA.

New York: 49 Dey St. Pittsburg: Park Building
CHICAGO: LINK-BELT MACHINERY COMPANY

Please mention The Engineering Magazine when you write.

CAMERON STEAM PUMPS.



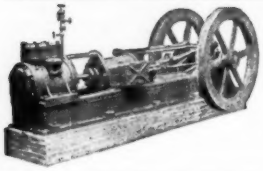
SIMPLE,
COMPACT
DURABLE
RELIABLE,
EFFICIENT.

NO OUTSIDE VALVE GEAR.

Easily Started. Easily Stopped. No Dead Centre. Built for Hard Usage. Suitable for every use.

Our New 112 Page Catalogue can be had for the Asking.

A. S. CAMERON STEAM PUMP WORKS, NEW YORK.
FOOT EAST TWENTY-THIRD STREET.



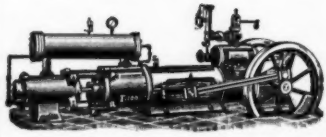
AIR COMPRESSORS For Air Lift and Well Pumping.

And for Rock Drills, Coal Cutters, Air Hoists, and Pneumatic Work Generally.

STEAM PUMPS FOR ALL PURPOSES. Correspondence Solicited.

HALL STEAM PUMP CO.,
PITTSBURG, PA., U. S. A.

THE AMERICAN WELL WORKS "LIGHTNING WELL MACHINERY"



MANUFACTURERS OF
AIR LIFTS,
AIR COMPRESSORS,
DEEP WELL PUMPS,
GASOLINE ENGINES,
WELL MACHINERY.

CHICAGO ILL. DALLAS TEX. AURORA ILL. U.S.A. WRITE FOR CATALOGUE

Deane Steam Pump Co. of Holyoke,

Manufacturers of Pumping Machinery of all kinds. Steam and Power Pumps for Paper Mills a specialty. Send for special catalogs and circulars.

Chicago, Boston, Philadelphia.
WORKS: Holyoke, Mass.

120 LIBERTY STREET, NEW YORK.

1864 MORRIS MACHINE WORKS 1901

BALDWINSVILLE, N.Y., U.S.A.

CENTRIFUGAL PUMPING MACHINERY

Oldest, Largest and Strongest Concern of its kind in America. We Invite Correspondence.

New York Office 39-41 Cortlandt St., Chicago Office 61-69 N. Jefferson St.

The Laidlaw-Dunn-Gordon Co.,

All kinds of Pumping Machinery, Air Compressors, also Tobacco Machinery, Presses, etc. Send for catalog.

New York, Boston, Chicago, Philadelphia.
WORKS: Elmwood Place, Ohio.

CINCINNATI, OHIO.

A CARD INDEX

applied to indexing things the engineer wants to refer to. Ask for circular.

THE ENGINEERING MAGAZINE,

NEW YORK.

PATTERN LETTERS

For Iron and Brass Castings, for Machines, Bridges, Tablets, etc. Various styles and sizes. Leather Fillet. Write for Prices.

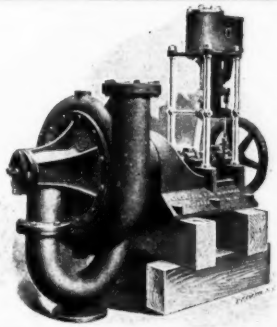
A. G. BUTLER,
Corner Beekman and Pearl Sts., New York.

The Standard Water Meters AND Tuerk Water Motors

Are Manufactured by

THE STANDARD WATER METER CO.,
22-26 Reade St., NEW YORK

Successors to Tuerk Hydraulic Power Co.



Centrifugal Pumping Machinery,

MARINE ENGINES and BOILERS,

EXCAVATORS.

KINGSFORD FOUNDRY AND MACHINE WORKS,

OSWEGO, N. Y., U. S. A.

PULSOMETER STEAM PUMP.

"THE CONTRACTOR'S FRIEND"

Often Imitated—Never Equaled. Over 20,000 in Use.

RECENT IMPORTANT IMPROVEMENTS.

The Handiest Simplest and Most Efficient Steam Pump for General Mining, Quarrying, Railroad, Irrigating, Drainage, Coal-washing, Tank-filling, Paper Mill, Sewer and Bridge Contractors' Purposes, etc., etc.
Muddy or gritty liquids handled without injury to the Pump.

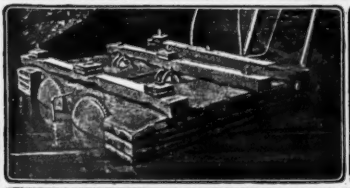
PULSOMETER STEAM PUMP CO.

Catalogue on Application.
Correspondence Solicited.

135 Greenwich St., New York.

Please mention The Engineering Magazine when you write.

The HARRIS COMPOUND DIRECT AIR PRESSURE PUMP



A SENSIBLE WAY OF USING COMPRESSED AIR FOR PUMPING.

PNEUMATIC ENGINEERING CO. 128 BROADWAY. N.Y.

Knowles Steam Pump Works,

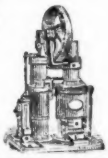
Pumping Machinery of all kinds, Steam and Power, Mining, Electric, Air Compressors, Air Pumps and Condensers. Send for special catalogs.

Boston, Chicago, Philadelphia, London. 91 LIBERTY STREET, NEW YORK.

HALF ENOUGH WATER is quite enough for some people, but most people want water every day. If **RIDER or ERICSSON HOT AIR PUMPS** are used you can have water every day in the year, and your cook or stableboy is the only engineer needed. 25,000 in daily use. Catalogue "B 7" on application to nearest store.

RIDER-ERICSSON ENGINE CO.,

22 CORTLANDT ST., NEW YORK. 40 DEARBORN ST., CHICAGO.
239 FRANKLIN ST., BOSTON. 40 N. 7TH ST., PHILADELPHIA.
692 CRAIG ST., MONTREAL, P. Q. TENIENTE-REY 71, HAVANA.
22A PITT ST., SYDNEY, N. S. W.



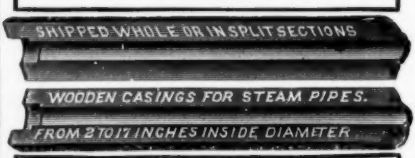
For Card-Index Uses.

For the convenience of those who desire to preserve indexed items, in card-index form, THE ENGINEERING INDEX is issued separately from the Magazine, printed on one side of the paper. Ask for a specimen of it. . . . . .

Consult the Engineering Index in this number.

WATER PIPE.

Railroads, Mines, Distilleries and Pulp Mills.



STEAM PIPE CASING

For Underground Steam Lines. The CHEAPEST and BEST Non-Conductor Made.

CREOSOTED CONDUIT

For Underground Wires of all Kinds. Cheap, Durable and Perfect.

These products are extensively used in Municipal and Railroad work. We can furnish reports showing Economy and Adaptability in all kinds of Service.

THE MICHIGAN PIPE CO.,

BAY CITY, MICH.

United States Cast Iron Pipe & Foundry Co.,

MANUFACTURERS

CAST IRON PIPE

Large Cylinders,
Flange Pipe,
Foundry Work.

Eastern Office, Land Title Building, Broad and Chestnut Streets,
PHILADELPHIA.

Holly Manufacturing Co.,

Water Works Pumping Engines. Large variety of patterns. Send for special catalogs.

Boston, Chicago, Philadelphia.
WORKS: Lockport, N. Y.

120 LIBERTY STREET, NEW YORK.

WELL DRILLING Machines

Over 70 sizes and styles, for drilling either deep or shallow wells in any kind of soil or rock. Mounted on wheels or on sills. With engines or horse powers. Strong, simple and durable. Any mechanic can operate them easily. Send for catalog.

WILLIAMS BROS., ITHACA, N. Y., U. S. A.

A Ready Means

Of finding any data an Engineer may need. Write for our "Index Circular."

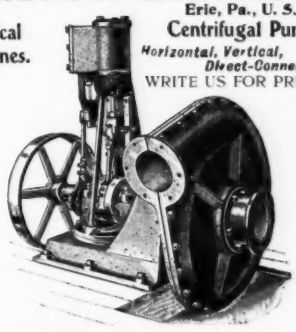
THE ENGINEERING MAGAZINE.
120-122 LIBERTY STREET, NEW YORK.

ERIE PUMP & ENGINE CO.

Erie, Pa., U. S. A.

Vertical Engines.

Centrifugal Pumps.
Horizontal, Vertical, Direct-Connected.
WRITE US FOR PRICES.



The Geo. F. Blake Mfg. Co.,

Pumping Machinery for every possible duty. Send for special catalogs. Marine Pumps, Sugar House and Sugar Plantation Pumps.

Boston, Chicago, Philadelphia, London. 91 LIBERTY STREET, NEW YORK.

REFRIGERATING AND ICE MAKING MACHINERY.

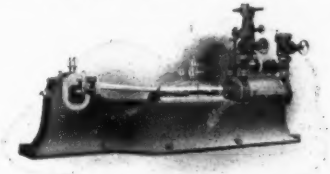
BARBER COMPRESSORS

BELT POWER OR DIRECT CONNECTED WITH ENGINE.

Twenty different sizes, from 3 to 50 tons.

OVER 500 in successful operation.

Send for Booklet "B." Giving list of users and letters from them.



WE MANUFACTURE

COILS

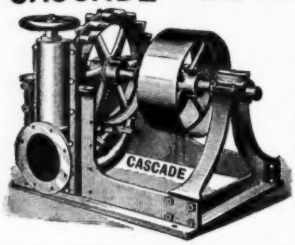
OF ALL KINDS,

Ammonia Valves and Fittings.

Catalogue sent on application.

BUILT BY
A. H. BARBER MFG. CO.
229 South Water St., CHICAGO, ILL.

TURBINE AND CASCADE WATER WHEELS



Adapted to all Heads from

3 FEET to 2000 FEET.

Our experience of **39 YEARS** building Water Wheels enables us to suit every requirement of Water Power Plants. We guarantee satisfaction.

Send for a Pamphlet of either Wheel and write full particulars.

JAMES LEFFEL & CO.

SPRINGFIELD, OHIO, U. S. A.

CHRISTIANA MACHINE CO.,

Established 1862. **CHRISTIANA, Pa., U. S. A.**

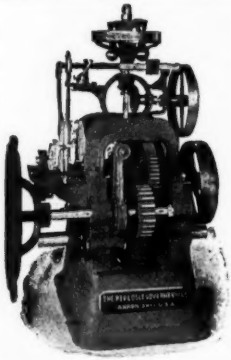
ENGINEERS, FOUNDERS AND MACHINISTS,

Manufacturers of TURBINE WATER WHEELS, adapted to all duties.

Power Transmitting Machinery.

Gearing, Rope Wheels, Friction Clutches, Shafting, Pulleys, Hangers, Etc.

☞ *Catalogues on application.*



WATER-WHEEL GOVERNORS

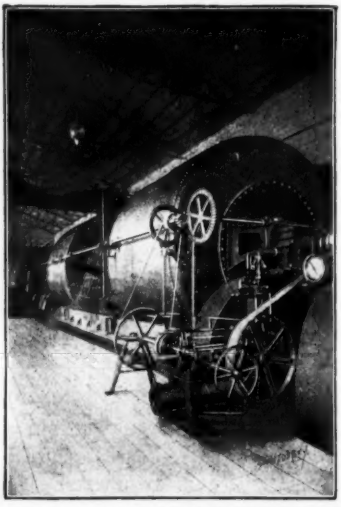
FOR

ELECTRIC LIGHTING, POWER.... AND RAILWAY PLANTS.

The Replogle Governor Works,

AKRON, OHIO, U. S. A.

McCormick Turbines.



THIS illustration shows a Pair of McCormick Turbines operating generators in the power plant of the Boston & Montana Consolidated Copper & Silver Mining Co., Great Falls, Mont. Head, 40 feet; 2,800 horse power. Weight, 300,000 lbs. irrespective of draft tube, supply pipes and power connections. ***The heaviest pair of turbines built. These turbines were tested at Holyoke and gave 85 per cent. efficiency.***

Undoubtedly the most popular turbine manufactured.

S. Morgan Smith Co.,

YORK, PA., U. S. A.

Write for Catalogue.

THE WATSON-STILLMAN CO.,

204-210 EAST 43d STREET,
NEW YORK CITY.

Forging Press.

HYDRAULIC PRESSES.

Jacks.

Plain Press.

Punches.

Curb Press.

SEND FOR CATALOGUE 5.

Snow Steam Pump Works,

Pumps for Mines, Water Works and every possible duty.

Boston, Chicago, Philadelphia.
WORKS: Buffalo, N. Y.

120 LIBERTY STREET, NEW YORK.

HYDRAULIC

Riveters—Fixed and Portable
Punches, Shears, Presses and Lifts
Traveling and Jib Cranes

CAST IRON PIPE

Send for Pamphlet.

MATTHEWS' FIRE HYDRANTS, GATE VALVES, VALVE INDICATOR POSTS.

R. D. WOOD & CO.,

ENGINEERS, IRON FOUNDERS, MACHINISTS,

400 CHESTNUT ST.
PHILADELPHIA, PA.

Henry R. Worthington,

Water Works and all kinds of Pumping Machinery, Water Meters, Cooling Towers and Condensers.

Boston, Chicago, Philadelphia, St. Louis, Pittsburgh, Atlanta, Cleveland, San Francisco, New Orleans, Butte, Kansas City, Detroit and Honolulu.

120 LIBERTY STREET, NEW YORK.

TANKS, AIR RECEIVERS, SMOKE-STACKS, WATER PIPE, AIR PIPE, Mixing Tanks, Hot Water Tanks, with and without Steam Coils, Filters, Contractors' Specialties and Heavy Sheet Steel and Sheet Iron Work of every Description.

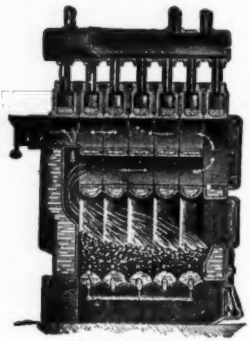
L. O. KOVEN & BROTHER,

WORKS, JERSEY CITY, N. J.

50 Cliff St., NEW YORK, U. S. A.

Cable Address: "KOVENLO."

STEAM AND WATER HEATING APPARATUS



MERCER BOILER.

FOUNDRY:
WESTFIELD, MASS.

For Public Buildings, Residences, Etc.

OUR SPECIALTIES:

Mercer, Mills, Gold and Cottage Steam and Water Heating Boilers. Adapted for Hard or Soft Coal and Wood Burning.

The Royal Union, Union, Princess, Imperial, Diadem, Coronet, and Sovereign Steam and Water Radiators.

Gold and School Pin Indirect Radiators for Steam or Water.

THE H. B. SMITH CO.,
133-135 Centre St., New York.
SEND FOR CIRCULAR.

NATIONAL FIREPROOFING COMPANY.

Pittsburgh. New York. Boston. Philadelphia.

BRANCHES:
Baltimore, Md.
Philadelphia, Pa.
Wilmington, Del.
Richmond, Va.
Manchester, Va.
Alexandria, Va.
Norfolk, Va.
Newport News, Va.

Guaranteed from Twelve to Twenty Years.

ASPHALT RUBBER PAINT BECKWITH

Especially Adapted for Railroad Work.

ASPHALT RUBBER ROOFING PAINT.

Unequalled for Iron, Tin, Steel or Felt Roofs.

World's Fair Award and a Written Guarantee goes with our Paint.
Send for Catalogue and Price List.

ASPHALT RUBBER PAINT CO.,
WASHINGTON, D. C.

THE ENGINEERING WONDERS OF THE WORLD.

"Giant" Portland Cement

"THE OLD RELIABLE."

Used exclusively on THE POWER HOUSE of the Metropolitan Traction Co. in New York with its 70,000 H. P. The largest single power building in the World. (*Eng. Record, Dec. 17, 1898.*)

THE AMERICAN CEMENT CO., 22 South 15th St., Philadelphia, Pa.

Cement ?

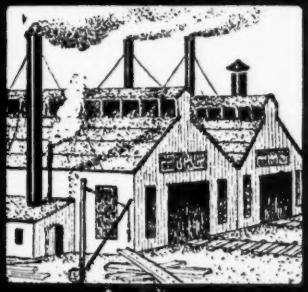
Lägerdorfer Portland Cement is the strongest and most serviceable cement made, and will permit the admixture of a larger amount of sand or gravel with less loss of strength than any other brand; therefore, it is the most economical.

A very handsome book about cements, their manufacture and characteristics, with many fine illustrations of notable masonry work, is sent to anyone, free of charge, upon request.

LÄGERDORFER PORTLAND CEMENT FABRIK VOM LUDW. LAMPE & CO. HAMBURG

THE KELLEY ISLAND LIME & TRANSPORT CO., CLEVELAND, Ohio.

ASPHALT PERFECTED GRANITE ROOFING



"Ready to Wear."

Cheap, Durable, Sightly, Fireproof.

The best roofing in America for factories, bleacheries, chemical works, mine breakers, company plants, and industrial buildings generally. Millions of feet in use throughout the United States, Canada and Mexico.

PERFECTED GRANITE ROOFING

has stood the test for 17 years.

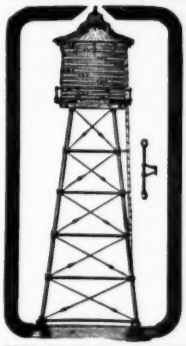
SEND FOR SAMPLE AND CATALOG.

The Eastern Granite Roofing Co., Gerken Bldg., New York.

248

T. H. BROOKS & CO. CLEVELAND, O.

FLOOR & SIDEWALK LIGHTS.
OF EVERY DESCRIPTION.
SEND FOR CATALOGUE.



CALDWELL TANKS & TOWERS

FOR

WATER SUPPLY AND FIRE PROTECTION.

Illustrated Catalogue and Price List on application.

W. E. CALDWELL CO.
212 BROOK ST.,
LOUISVILLE, KY.

WATER SUPPLY OUTFITS,

RAILROAD, PRIVATE, MUNICIPAL.

STEEL / WOOD **SUBSTRUCTURES**

GALVANIZED AND PAINTED.
SUBSTANTIAL. SYMMETRICAL.

Washington Fir, Louisiana Cypress, Galvanized Steel, **Tanks**

STAR WIND MILLS.

Galvanized Steel or Wood, adapted for farm, residence, power or irrigating purposes.

Designs and Prices Furnished. Write for Catalogue.

ADDRESS

Flint & Walling Manuf'g Co., 508 OAK STREET, KENDALLVILLE, IND.

American Bridge Company

OF NEW YORK.

ENGINEERS AND CONTRACTORS.

Structural Steel and Iron,

BUILDINGS, BRIDGES, ROOFS, TRUSSES.

General Offices: 100 Broadway, N. Y.

European Office: London.

BALDWIN LOCOMOTIVE WORKS,

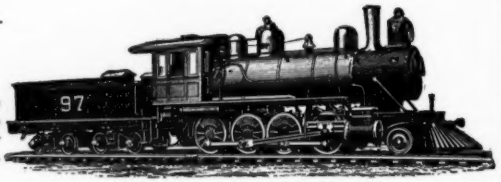
ESTABLISHED 1831. ANNUAL CAPACITY, 1200

Locomotive Engines

adapted to every variety of service and built accurately to standard gauges and templates.

Locomotives for Logging, Railroad & Sugar Estates, Electric Locomotives, Compressed Air Locomotives.

Compound Locomotives,
Steam Cars,
Steam Tramway Motors.
Mine Locomotives,
Furnace Locomotives.



BURNHAM, WILLIAMS & CO., Proprietors.

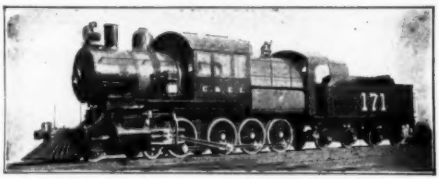
PHILADELPHIA, PA., U. S. A.

American Locomotive Co.,

Builders of Single Expansion and Compound Locomotives for all classes of service, from original designs or from specifications furnished by purchasers. . . . . .

OWNING AND OPERATING THE

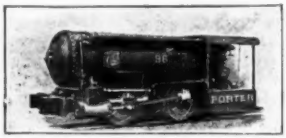
Schenectady Locomotive Works, Schenectady, N. Y.
Brooks Locomotive Works, Dunkirk, N. Y.
Pittsburg Locomotive Works, Allegheny, Pa.
Richmond Locomotive Works, Richmond, Va.
Cooke Locomotive Works, Paterson, N. J.
Rhode Island Locomotive Works, Providence, R. I.
Dickson Locomotive Works, Scranton, Pa.
Manchester Locomotive Works, Manchester, N. H.



President,	S. R. Callaway.	Treasurer,	C. B. Denny.
Vice President,	A. J. Pitkin.	Comptroller,	J. E. Patterson.
Second Vice President,	R. J. Gross.	Mechanical Engineer,	J. E. Sague.
Secretary,	Leigh Best.	General Purchasing Agent,	H. C. Hequembourg.

General Offices: - - 25 Broad Street, New York City.

H. K. PORTER CO., Bank of Commerce Bldg., PITTSBURGH, PA., U.S.A.



Compressed Air Locomotive, Class B P, No. 96.

LIGHT LOCOMOTIVES of all gauges of track, from three to forty-five tons weight, including special designs for mines, mills, furnaces, plantations, logging, contractors' use, passenger and freight service, suburban service, street railways and industrial establishments. **COMPRESSED AIR LOCOMOTIVES** for underground or surface work at coal, iron, copper, silver, gold and other mines, and for surface work where smoke or sparks must be wholly eliminated.

Locomotives, wide and narrow gauge, on hand.

41

Kyanized Lumber.

If you are not familiar with the process and its uses, send a 2c. stamp for our beautifully illustrated pamphlet on "The Artificial Preservation of Timber." It will give you a great deal of information on the subject.

The process of Kyanizing has a test of more than fifty years of actual practice back of it. You cannot afford to neglect its use.

WRITE US AND ENQUIRE ABOUT IT. - - **OTIS ALLEN & SON, Lowell, Mass.**

Please mention The Engineering Magazine when you write.

GOODWIN CAR CO.,

96 Fifth Ave., New York.
115 Dearborn St., Chicago.
213 Tremont Bldg., Boston.

ADDRESS ALL COMMUNICATIONS TO NEW YORK OFFICE.

THE GOODWIN CAR

Built with open Crate or covered top. Cars leased only.

TRADE MARK

Controlling and Operating Patents for Dumping Cars, Vessels, Wagons, Barges, Bins. Trestles, Chutes, and the like.

Steel construction combined with malleable iron, especially adapted for discharging Ore, Coke, Coal, Gravel, Large Rock, Broken Stone, Pig Iron, Castings, Machinery, Loose Grain, Steel Billets, Tin Plate Bars, Rail Ends, Hot Cinders, and many other similar materials by the gravity of the load alone without careening the car body.

Standard Running Gear—80,000 lbs. Cubic Capacity—Level load, from 32 cubic yards to 83 cubic yards.

SILVER MEDAL, PHILADELPHIA, 1899.
SILVER MEDAL, PARIS, 1900.

Latest Pattern, Class "G," Goodwin Car with Coke Crate Top.

The special constructional, as well as dumping, advantages of the Goodwin Patent Steel Gravity Dumping Car over any other steel or wooden car in existence are:

1st. Their greater saving in the cost and time of transporting and unloading all dumpable materials.

2d. Their greater ability than any wooden car or other Steel Car to resist all crushing and pulling strains and all damaging effects from warping and bulging, caused by the excessive expansion and contraction from carrying either red hot or stiff frozen loads.

3d. The Goodwin Patents cover the only Steel or Wooden Cars built that dump either large or small material equally well, on either or both sides, or in the center, without careening the car or movement of the car body.

4th. They are the only cars built from which one man, while the train is in motion, can discharge the entire train load of large or fine material at the same instant by the aid of compressed air, steam or electricity, depositing the load either between the rails or outside or both, at the same time.

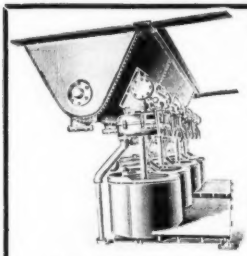
5th. They are the only cars built in which the freezing of a load of rock, coal, ore, or any similar material in the car does not materially interfere with the discharge of the load.

6th. They are the only cars ever built or patented that can be used equally well for the combined purposes of either the usual Hopper or Tip-Dumping Car or the Center or Side Ballasting and Filling Cars, or for handling and discharging all kinds of Way Freight and General Merchandise conveniently and economically, on level ground without trestles, using the gravity of the material alone as the unloading power.

Some further claims for the Goodwin Patent Steel Gravity Dumping Cars, which may be claimed for any other large capacity Steel Cars, if built on engineering principles, compared with general wooden car construction, are:

Cost of repairs reduced about 50 per cent. Increased ability to withstand rough usage, shocks and collisions. Less wear and tear on tracks and on cars. Longer life. Greater salvage value. Higher speeds attainable on rough and uneven tracks and on curves, due to special center plates and side bearings and to truck construction. Increased cubic as well as ton capacity. Greater percentage of paying load to dead load.

Please mention The Engineering Magazine when you write.



Weston Water Motor Centrifugal.

WESTON CENTRIFUGALS,

Sugar Machinery, Elevators and Carriers.

The latest thing in Centrifugals is the Weston Patent Centrifugal Machine, with the Watson, Laidlaw & Co.'s Patent Water Motor attached to the same.

Turret Lathes, Friction Clutches, Milling Machines, Chucks and Slide Rests, Hangers, Oil Separators, Belt Knives, Belt Knife Splitting Machines and Rubber Rolls for same. SEND FOR CATALOGUE.

American Tool and Machine Company,
BOSTON, MASS., U. S. A.

GUILD & GARRISON,

Kent Ave., cor. South 10th Street.
Take Roosevelt, Grand or E. 23d Street Ferry from New York.

BROOKLYN, N. Y.

STEAM PUMPS.
VACUUM PUMPS.
FILTER-PRESS PUMPS.
DRY AIR COMPRESSORS.
VACUUM APPARATUS.
CONDENSERS.
AMMONIA PUMPS.
ACID BLOWERS.

WESTON STANDARD PORTABLE

VOLTMETERS, AMMETERS, WATTMETERS.

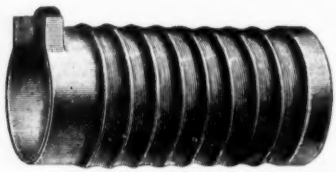
Strictly high-grade. Recognized as Standards.

Weston Electrical Instrument Co.,

Waverly Park, Essex Co., N. J.

BERLIN: European Weston Electrical Instrument Co., Ritterstrasse, 88.
LONDON: Elliott Bros., 101, St. Martin's Lane.

MORISON SUSPENSION FURNACES



FOR LAND AND MARINE BOILERS.

UNIFORM THICKNESS,
EASILY CLEANED,
UNEXCELLED FOR STRENGTH,

ALSO,

FOX CORRUGATED FURNACES.

Sole Manufacturers in the United States.

THE CONTINENTAL IRON WORKS,

West and Calyer Streets, Near 10th and 23d St. Ferries. **NEW YORK,** Borough of Brooklyn.

Lidgerwood Hoisting Engines

OVER 17,500 IN USE.

ARE BUILT TO GAUGE ON THE DUPLICATE PART SYSTEM.

QUICK DELIVERY ASSURED.

STANDARD FOR QUALITY AND DUTY.

The "LIDGERWOOD" HOISTING ENGINES are strictly High-Grade in every particular and accepted as the STANDARD Modern High-Speed Hoisting Engine, both as regards High Duty and Economy, Durability and Simplicity, combined with ease and rapidity of Operation.

FOR PILE DRIVING, RAILROADS, CONTRACTORS, COAL YARDS, SHIPS, BRIDGE BUILDERS, DOCKS, QUARRIES, MINES

AND GENERAL HOISTING PURPOSES.

Cableways

Hoisting and Conveying Devices

FOR

MINING, QUARRYING, STEAM LOGGING, DAM CONSTRUCTION, ETC.

Steam and Electric Hoists.

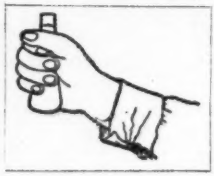
SEND FOR LATEST CATALOGUE.

LIDGERWOOD MFG. CO.,

Chicago, Boston, Philadelphia, Pittsburg, Atlanta, New Orleans, Portland, Ore., Cleveland, O.

96 LIBERTY STREET, NEW YORK

...PULL COUNTERSHAFTS...



The belt is shifted from the loose to the tight pulley, and vice-versa, by simply pulling a small rope. There is only one thing to do -- PULL! Positive, durable, simple, economical, self-oiling. The most satisfactory countershaft on the market.

Sold by all Leading Dealers.
Circulars.

BUILDERS IRON FOUNDRY, - Providence, R. I., U. S. A.

B TRADE MARK

Jenkins Bros.' Valves

are manufactured of the best steam metal, and are fully guaranteed. Why experiment with cheap valves? If you want the ***BEST*** ask your dealer for valves manufactured by Jenkins Brothers. Remember all genuine are stamped with Trade-Mark like cut.

JENKINS BROTHERS, New York, Philadelphia, Chicago, Boston.

SMALL STEEL CASTINGS, SOFT AND EASILY MACHINED.
MALLEABLE IRON CASTINGS,

STANLEY G. FLAGG & CO.,
PHILADELPHIA, PA.

The Niclausse Water Tube Marine Boiler.

In use in the following Navies:

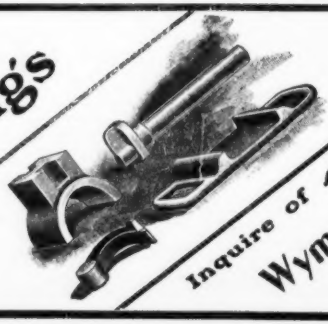
ENGLAND,	FRANCE,	RUSSIA,	ITALY,
GERMANY,	SPAIN,	ARGENTINE,	CHILI.

60,000 H.-P. now in course of construction at our Works for the Russian Cruiser "VARIAG," the Russian Battleship "RETVIZAN," the United States Monitor "CONNECTICUT," and the United States Battleship "MAINE," now building at the Wm. Cramp & Sons Ship Yards, Philadelphia, and the Bath Iron Works, Bath, Me.

THE STIRLING COMPANY,

General Offices, Pullman Building, CHICAGO, ILLINOIS.

Drop Forgings



Inquire of
Wyman & Gordon,
Worcester, MASS.